GENERAL SCIENCE QUARTERLY

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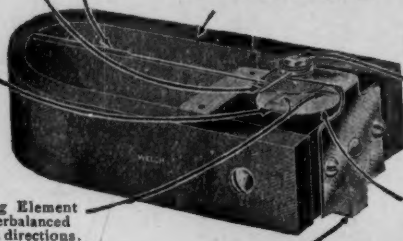

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General Science Quarterly

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Service the Needed Spirit of Modern Science Instruction [1]

BY OTIS W. CALDWELL, Director Lincoln School, Teachers College, New York City

I. *What we are trying to do.*—This discussion proceeds upon the theory that the best education for young people of secondary school age should be best for them whether they do or do not go on to college. Further, it is assumed that those who go to modern colleges, as those who do not go, are in great need of a sound general education touching upon the knowledge and the arts which enter into current life. All need an education which shall illuminate knowledge and art and by use of them shall develop attainable social and personal ideals concerning those aspects of modern knowledge and arts which enter into the lives of young people. It may even be argued that those who go to college are, in proportion to their numbers, more greatly in need of a socially meaningful secondary education, since they are later to have opportunities for larger intellectual influence and thus need to be more secure in their understanding of the real human services of modern secondary and collegiate scholarship. A further basis of this discussion is found in the fact that much more study has been made in the past decade bearing upon improvement of secondary school subjects and methods than has been made in college subjects and methods. Therefore, it is appropriate that college subjects and requirements shall be studied, to the end that they may adequately continue the slowly but definitely improving secondary school subjects.

1 This was read as a paper before the meeting of the Association of Colleges and Preparatory Schools of the Middle States and Maryland, Washington, D. C., November 28, 1924.

ADVANCEMENT IN SCIENCE EXCEEDS OTHER BRANCHES.

In the following discussion of the sciences, it is not to be inferred that they are regarded as being either more or less important than other subjects of instruction. It is probably true that more advancement has recently been made in science instruction than in most other secondary subjects.

II. *The public believes in science.*—It is not news to state that appropriations of public funds are more readily procured for agriculture, for household arts, or for engineering than for most other purposes. So well recognized is this fact that programs for general education or for other purposes are frequently associated with applied science for the sake of the increased hope of successful support. The common people believe in the kinds of science which yield benefits which they can see clearly and soon. They are slowly, but steadily, coming to believe in the development of scientific principles whose fruits may be more ultimate but possibly more important.

BENEFITS OF SCIENTIFIC DISCOVERY QUICKLY ACCEPTED.

III. *The public uses science.*—The public use of science is so constant as to make even a meager picture of it impossible. All our working days and all our sleeping nights are ordered upon the uses of modern sciences. Surely no advocate of an improved science teaching can quibble about the public's being slow to use the material fruits of modern science knowledge. There may be a few belated users of science, but natural processes of removal of the ill-adjusted seems soon to catch those who lag too far behind the advancing crowd of modern peoples. Educationists need have no great worry as to whether the immediate material benefits of scientific discovery will be accepted by most people. Whatever may be thought or said about the educational use of the sciences in schools and colleges, current life has accepted the sciences, and constantly asks, expects, and receives the cumulative material benefits of modern scientific thought.

IV. *Science is everywhere, both in affairs and in schools.*—The quantitative use of the sciences in common affairs and in schools and colleges is now more extensive than at any preceding time. Dr. E. R. Downing, who has given much time to a study of the sciences in Europe and in America, says that we teach as much science in elementary schools as is taught in Europe, and that it is done better in this country. Also during the past 10

years there has been an increase in science in the elementary schools of the United States.

In high schools there has been large increase in the quantity of science instruction, the greatest increase having been in those commonwealths in which definite programs of science sequences have been adopted. In Pennsylvania, for example, in the State report of 1923, a student registration increase of 19.8 per cent is recorded in one year, based upon a calculation including all four-year high schools within the State. So far as recorded this is the largest yearly increase in any State.

In colleges and research institutions, there has been great increase in the provisions for and acceptance of opportunities for work in the sciences. Independent industries have very generally established research departments which are adequately supported and are manned as well as it is possible for them to be with the present training of research workers. New science knowledge is constantly coming from these and other centers of careful study, to such an extent that we are no longer surprised to have our daily paper make announcements of discoveries of very great import. Great discoveries are now so frequent that we note them almost as the expected content of the daily press.

SECONDARY COURSES SUMMARIES OF COLLEGE COURSES.

V. *What has caused the change in the science situation in high schools?*—The recent and unprecedented growth and refinement of science knowledge has produced many new branches of science, each with its own "ology"; each with its own body of special knowledge, methods, and special workers. In many cases these special and highly refined subjects were crowded into the secondary schools, and at the same time the ancestral body of common aspects of science were crowded out. The secondary courses became summaries of collegiate courses, not elementary insights into significant topics for young people. The extent to which this is true is not realized by those who have not made a study of the facts in the case.

Let us take collegiate and secondary physiography as an example, and compare a comprehensive college textbook in the subject with a secondary schoolbook in the same subject by the same author. Possibly the best college text ever written in this subject is Salisbury's Physiography, which appeared in 1907. His high-school text appeared in 1908. The college text is for students who

elect the course in any college year. The high-school text is for use, as the author says, "For first or second year high-school pupils." The college text has 770 pages; the high-school text, 531 pages. The college-book pages are larger than those of the high-school text. The college book has 707 illustrations; the high-school book has 469, the latter being almost always identical with the same number used in the college book. There are 24 maps in the high-school book, 14 of which are identical with 14 of the 26 in the college book, 7 others being almost identical with those of the college book, thus making 21 of the 24 maps almost or quite identical with those of the college book. There are 26 chapters in the college book and 20 in the high-school book; however, 17 of those of the high-school book are the same as 17 of those of the college book; one other high-school chapter is composed of 2 college chapters combined, without material change of the topics or contents; and another high-school chapter on the topic "The ocean" consists of a combination of 5 college chapters which in the college text are upon subdivisions of the topic, "The ocean." In the high-school book the chapter dealing with the ocean has five subdivisions, each of which has exactly the same heading as that of the corresponding college chapter. Within the text matter many sentences are identical with those of the college text, the condensation having been secured in the main by clipping—not by rewriting.

DIFFERENCES IN TYPICAL TEXT MADE BY OTHERS.

We have, however, accounted for but 19 of the 20 chapters of the high-school book, though we have accounted for the 26 chapters of the college book. The added high-school chapter which does not appear in the college book is upon the topic "Physiography and its effects on plants and animals," this chapter having been written not by the physiography author but by two teachers who had taught younger people.

It is not likely that such a close analysis could be made for many such cases, but the same point may be clearly demonstrated by a study of college and high-school books in physics, chemistry, zoology, botany, and physiology.

In a sense, it may be said that the very success of scientific advances in our time has caused the objectionable high specialization in secondary schools. College specialists have set special technicalities as the body of requirements to be learned by secondary pupils.

DISSATISFACTION WITH INTRODUCTORY COURSES.

VI. *Dissatisfaction with technical work in science for the early years of high school.*—Dissatisfaction became most notable in the early years of secondary schools. Many so-called introductory science courses were tried in one part of the country or another. These included courses in physiology and hygiene, physiography, biology, or separate course in botany and zoology; or even occasionally there were introductory courses in physics, chemistry, geology, and astronomy. With all this array of so-called introductory science courses, dissatisfaction with science instruction increased, while science knowledge itself grew in value and public recognition. The college science men, when they spoke of the results of secondary science, seemed to take little more comfort in the situation than did educators in general, though the illogical conclusion was often stated that young people would do better and like sciences more if they were compelled to take more of them. Compelling people to do distatsteful things always has been a delusion of formalists. It seems not to have occurred to collegiate science to look into a reflecting mirror for part of the cause of the trouble.

VII. *A new type of introductory science course.*—Some 15 years ago several groups of science teachers began to use the methods of science itself in trying to develop the contents and methods of a more useful introductory science course. These groups formulated hypotheses as to what secondary science might perchance do for young people, then selected materials and methods designed to see if the hypotheses could be realized. It was found that the various introductory courses contained much very useful factual material, and that these materials from several introductory courses then in use could be more productively organized if a topical plan of unification were used instead of the special science subject plan. Thus came the course in general science. No one who is observing the workings of this course believes, I presume, that its organization or methods or outcomes are now definitely determined. Perhaps they may not soon be, possibly should not be, but the startling and widespread success of this type of science course is one of the outstanding achievements of modern science.

GENERAL SCIENCE COURSES FRUITFUL.

VIII. *The unprecedented success of the course in general science* should be interpreted.—Various statistical studies of separate States, sections of the country, and of the whole United States show the same types of results so far as numerical evidence is concerned. Only a few of these studies can be cited here. The Pennsylvania study, previously referred to, shows that of the approximately 202,000 four-year high-school pupils in that State in 1922-23 approximately 54,000 were studying general science, and more were studying the other sciences than before general science was introduced. Dr. Edna M. Bailey, in a recently published and detailed study of California's four-year high schools of all classes, shows that in 1922-23, 71.2 per cent of all California four-year high schools taught general science; also that the subject is in the junior high schools throughout the State.

Dr. F. E. Bolton, in a study in the State of Washington, finds that one-sixth of all pupils are now registered in general science, almost one-sixth in biology, and as large a proportion in physics and chemistry as before general science was introduced.

BUREAU OF EDUCATION'S STATISTICS.

The report of the United States Commissioner of Education for the school year 1921-22 shows that in 13,700 public high schools there was an enrollment of approximately 400,000 students in general science.

The point of view of general science is slowly finding its way into the other high-school sciences. There does not seem to be a need of any reduction in quantity of learning in any special science subject; indeed it seems likely that the quantity of learning is being considerably increased. Its nature is somewhat changed, and this change toward a more significant science instruction should be useful both to high school and to colleges, but most useful of all to citizens. Are the science men, the specialists, really willing to have their subjects changed for this larger usefulness? If not, may we inquire whose property are these science subjects?

The question, therefore, of whether the public desires a new type of science instruction seems clear. It is amusing to have the question raised as to whether college boards will accredit for college entrance a course which has found a place of such service in modern secondary education. Possibly these boards wish to put their own organizing and refining hand upon the course before

giving it full recognition. They are respectfully requested to recall what occurred in the special science under these same hands.

IX. *There is a world movement toward changing science instruction.*—In 1921 our Bureau of Education published a report on secondary science instruction. This report was the result of seven years of work of a committee of 50 persons. Their recommendations are most important and are based not upon theory alone but upon practice in the best schools. It is the type of science sequences recommended in that report which is now operative in Pennsylvania, California, and most other States of the Union.

In 1918 a British science commission published a very comprehensive report by a committee, of which Sir J. J. Thompson was chairman. The recommendations of that report are in spirit and in many details closely like the United States report.

SCIENCE STUDY A WORLD MOVEMENT.

In the Orient everywhere one goes he hears of movements to improve and increase science instruction. It is a world movement, the whole civilized world realizing that the achievements and method of thought of modern science must be possessed by those who would aspire to progress.

X. *Why a new point of view of science instruction?*—Science knowledge and scientific methods of work are conspicuous features of modern life. Nature is being brought under control by man's mind. We know more of nature's truths than at any previous time in human history. We can fly or speak around the earth. We now know of ether waves by means of which new sense organs are created, as has been done with the radio. Indeed, the radio is nothing more than a new kind of ear which hears by use of wave lengths for which nature made no ear. We know of light waves, by which we could see around the earth if only we had the right kind of eye to use these waves, and some time we may possess such an eye. There seems almost no limit to scientific accomplishment.

PROPER USE OF SCIENCE THE NEEDED DEVELOPMENT.

It is a matter of very great import to human beings whether modern science is learned by modern peoples merely that it may be used. If that is all, it is bad for those who learn it. Science knowledge has grown and will grow so that undreamed control of forces and materials will be had. Can the race be trusted with controls without an accompanying sense of responsibility for the

knowledge thus possessed? The *proper* use of science in modern life, not only the *possibilities* of its use, must be developed in our courses of science instruction for young citizens in a free country. Such a sense of social and moral obligations we dare not omit, else we shall have an increased speed and quantity of living without the restraining anchorage of social responsibility. "Knowledge is power," either for good or bad ends, but knowledge for social service must supplant the mere power idea.

It is not now safe for society nor for some nations to possess certain knowledge which science now possesses. Disease bacteria, properly understood and properly placed, will destroy whole cities. Until people do not wish to destroy their enemies or their competitors they must not possess the means or knowledge for doing so. Science courses for all the people must help all the people to interpret science for service, not science for power. Service, not power to control, is the needed spirit of modern science instruction.

Molds, Mildews and Bacteria

LILLIAN J. MCRAE, Teachers College of the City of Boston.

A SHORT study of these lowly plants offers opportunity to the pupils of the intermediate grades to experiment, and through their own activities to learn the importance of molds, mildews and bacteria to man. The experiments should be used to answer the "Why" in many of the rules of hygiene, in Board of Health regulations, and in home and community habits.

Molds and mildews are the easiest forms to begin with. Let the teacher take a slice of bread, dampen it, place it on a plate, and cover with a tightly fitting glass dish. If more convenient a half slice of the bread can be put into a quart preserve jar. Show the pupils that it is put in a warm, dark place. Each pupil is asked to put half a slice of bread into a pint jar, dampen it, put on the cover, and place the jar in a warm, dark place at home. In about a week the first short lesson can be taken. The pupils bring their jars to school and observations and comparisons are made.

The teacher takes a loaf of bread, and cuts several thick slices. These are dampened and placed on clean plates. Then with clean pincers a little of the black bread mold is touched over one slice of bread, and that slice is covered and put away. Having carefully cleaned the pincers in boiling water, plant another slice with

the blue mildew. As many cultures as desired are made in this way. These plates are looked at each day. When well grown, the class compare the cultures. They note the differences, they learn that these forms are plants that can be grown. They compare the rate of growth on the slices grown at home and the latest cultures made at school. The teacher calls attention to the sporangia on the bread mold and tells the pupils about the number of small spores contained in each one, the lightness which enables them to be scattered by the wind, and the fact that each one is able to grow into a large mold plant. Plant some spores on dry bread, plant some on damp bread and place in the sunlight. Let the pupils watch and later decide upon the conditions favorable to the growth of molds and mildews.

This work is then related to the care of foods. Let the pupils answer the questions: Why are pieces of bread dried before putting away for bread crumbs? Why does your mother scald out the bread box each week? Why do the starched clothes mildew sometimes? Why do the fruit growers wrap oranges in paper? The teacher may think of a large number of similar ones.

For a study of bacteria, the simplest satisfactory medium that I have used is potato agar. Boil a few slices of potato for about five minutes, drain off half a pint of water and filter through fine cloth. This water should be perfectly clear of sediment, add to it the potato water and note carefully the amount in the dish. Carefully boil this, adding boiling water to keep the amount in the dish the same, until the agar-agar is dissolved. This takes usually about 30 minutes. Filter through a fine cloth, little by little, at boiling temperature, into an erlenmeyer flask. Cork with a wad of cotton and sterilize on two successive days. Sterilize peti dishes. When ready for the lesson, melt the agar-agar and carefully pour into the sterilized petri dishes. Grow several cultures, such as obtained by exposure of the agar for a few minutes in the school room, an exposure to a cough, finger prints, exposure to a shake of a dust cloth, to the dust from a pocket in a coat. Place the cultures in a warm dark place and note the growth of colonies, note the different types of colonies. This work lends itself especially well to the hygiene lessons and helps the pupils to understand why dirty hands at meals are a menace to health, why dust cloths should be dampened and cleaned, why a handkerchief should be placed at the mouth when coughing, and many other points that any good teacher readily suggests.

The Articulation of General Science with the Special Sciences [1]

BY W. R. LEKER, Milwaukee University School, Milwaukee, Wis.

THE OBJECT OF THIS INVESTIGATION

THE purpose of this work is an attempt to find just where general science fits in with the sequence of science work as it is being developed in the high school. General science has made rapid progress and it is interesting to know why general science is occupying first rank as a science course. It is crowding out many other sciences that were once considered important.

Before taking up the articulation of the subject matter, the aims and progress of general science will be considered. The aims of authors and writers will be summarized as well as the opinions of teachers which have been gathered by questionnaires. In the progress of general science we can see what place general science is trying to fill in the curriculum.

The chief task in the problem of the articulation as here reported consists of finding the relation of the subject matter of general science texts to those of the special sciences, physics, chemistry, biology, zoology, botany, physiology, and physical geography. Then knowing the articulation of the subject matter it will be interesting to see how the general science course articulates with the other science courses. These two types of articulation should work together in a well organized system, and the following summary will give the material available for this discussion.

The analysis of the textbooks took several months of work, for it covers thirty-one books which total 14,524 pages. These pages are listed under 861 different topics which occur in table where all the sciences are tabulated together to show how they articulate. No effort was made to classify any topic which occupied any space less than one-fourth of a page in any of the books. In the entire work any page or part of a page was entered only once under some topic where the writer seemed to think it belonged. It may be mentioned here that this was a difficult task. To illustrate, I may take oxygen as an example. It depends upon how it

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1 The thesis from which this article is taken covers 133 pages. Many tables and explanations have been omitted. The summaries and conclusions are given. The thesis was written for the Education Department of Wisconsin University under the supervision of Professor W. L. Uhl.

is taken up as to where it should be assigned. It may come under combustion, oxidation, air, or oxygen itself, so if anyone else had analyzed the books there might be a slight variation. At any rate it does not transfer the pages to another special science, so the final outcome is the same regardless of under what topic it may be assigned. Several attempts were made before a system was worked out by which the topics could be arranged and no losses or duplications become registered. The illustrations in the texts were analyzed with the material and counted as such if they were good in explaining the topics.

In the selection of the texts to be used in the analysis, lists were obtained from representatives of the larger publishing houses which ranked the most used books of all the publishing companies. By using these lists and checking their result with the writer's ten years of science teaching, the following books were chosen and analyzed.

PHYSICS

Millikan & Gale, *Practical Physics.*
Dull, *Essentials of Modern Physics.*
Carhart & Chute, *Practical Physics.*
Black & Davis, *Practical Physics.*

CHEMISTRY

Newell, *Practical Chemistry.*
McPherson & Henderson, *Chemistry and its Uses.*
Brownlee and Others, *Elementary Principles of Chemistry.*

BIOLOGY

Moon, *Biology for Beginners.*
Smallwood, *Biology for High School.*
Hunter, *New Essentials of Biology.*
Peabody & Hunt, *Biology and Human Welfare.*
Gruenberg, *Elementary Biology.*

ZOOLOGY

Linville & Kelly, *A Text Book in General Zoology.*
Hegner, *Practical Zoology.*

BOTANY

Bergen, *Practical Botany.*
Coulter, *Elementary Studies in Botany.*

PHYSIOLOGY

Conn & Buddington, *Advanced Physiology and Hygiene.*
Walters, *Physiology and Hygiene.*

PHYSICAL GEOGRAPHY

Dryer, *High School Geography.*

Salisbury and Others, *Modern Geography.*

GENERAL SCIENCE

Barber, *Lessons in Science.*

Snyder, *Everyday Science.*

Hodgdon, *Elementary General Science.*

Tower & Lunt, *The Science of Common Things.*

Webb & Didcoct, *Early Steps in Science.*

Caldwell & Eikenberry, *Elements of General Science.*

Hunter & Whitman, *Civic Science in Home and Community.*

Van Buskirk & Smith, *The Science of Everyday Life.*

Trafton, *Science of Home and Community.*

Smith & Jewett, *Introduction to the Study of Science.*

Fall, *Science for Beginners.*

THE AIMS OF GENERAL SCIENCE

Most of the important aims of general science are presented by the authors of four recent texts which will be quoted first before giving summarized reports.

Caldwell & Eikenberry in the preface of their 1924 edition, *Elements of General Science,* state that, "Human experience includes results of modern science almost constantly. It is the object of this course to develop a usable fund of interesting and worth-while knowledge about common things. It is also its object to develop helpful and trustworthy habits of thinking about and of judging the common experiences which fall within the field of science. Particular interests and abilities of pupils are frequently revealed in science studies, and by recognizing and directing them more effective and profitable work may be accomplished in vocations or later studies."

Tower & Lunt in the 1922 Edition of their book, *The Science of Common Things,* make this statement to the boys and girls that study the book. "*The Science of Common Things* gives you many interesting and worth-while experiments about matter directly connected with your daily life, so that you will have a better understanding of what is going on about you. We want you to learn and observe closely, to think carefully, and to draw natural conclusions from the results of your experience. If you succeed in gaining these habits, you will be happier and much more successful all through life."

Hunter & Whitman in their 1923 book, *Civic Science in Home and Community,* state that, "Most of all a textbook should interpret to the child the part played by the various natural factors in their environment. It should conceive the child as a center, with all the world revolving around it. In this conception boys and girls become aware of the vital parts played by air, water, light, heat, and food on them as individuals within their homes. After the child has learned the meaning of these central factors in the home, the next step would be logically the application of the forces of nature by man in communal life."

Webb & Didcoct in their 1924 book, *Early Steps in General Science,* state that, "The true purpose of general science is to create a preliminary widespread interest in science as a thing of personal importance. Its study should increase the enrollment in the more advanced science classes for it will remove that ignorance concerning the general nature of science which, as every science teacher knows, causes many students to hesitate before entering the more specialized courses. Since this text does not encroach upon their recognized subject matter, it will recruit for them rather than compete with them."

Mr. Wallace H. Kiang who in 1924 wrote his Doctor's Thesis at Wisconsin University on the "Derivation and Development of Criteria in General Science," has the aims of forty-three authors and writers well tabulated. Summarized they rank as shown in Table I. The figures indicate the number of authors and writers mentioning the listed aims.

TABLE I

THE AIMS OF AUTHORS OF GENERAL SCIENCE TEXTBOOKS

Better understanding and control of environment	28
Information about nature and science	23
Preparation for later science courses	19
Training in scientific method	16
Development of power of interpretation and appreciation	14
Development of interest in science	11
Culture	10

Mr. Kiang sent out a questionnaire to the teachers of Wisconsin teaching general science and received 117 replies. Of this number, 95 reported that the primary aim of general science is to familiarize the pupil with his environment. Howe and Miller who made out similar questionnaires covering more territory found

that the understanding, appreciation, and control of environment was the chief aim of general science. Five men[2] have sent out questionnaires to teachers and their findings are shown in Table II.

TABLE II

THE AIMS OF TEACHERS OF GENERAL SCIENCE

AIMS	Roecker	Worun	Howe	Miller	Kiang	Total
(Approximate year of report)	1914	1917	1918	1919	1924	
(No. of replies to Questionnaire)	50	101	80	81	117	429
Understanding of environment	..	31	53	38	95	217
A fund of valuable information	33	19	12	18	..	82
Preparation for later science	31	47	6	11	9	104

SUMMARY OF AIMS

Space does not permit quoting in detail the findings of these men, but it is rather interesting to note the aims of general science as it is getting more firmly established. The early investigations seemed to put the chief emphasis on the preparation for later science courses, while the present investigations clearly show that to understand and control environment is the chief aim of general science.

The aims of authors, writers and teachers can be ranked about as follows:

1. Understanding, appreciation, and control of everyday environment.
2. A fund of valuable information which can be applied to one's industrial and social life.
3. A fund of valuable information about nature and science.
4. A preparation for later science courses.
5. Develop the ability to think clearly and interpret correctly.

(Many others of less importance may be mentioned.)

THE PROGRESS OF GENERAL SCIENCE

General science really had its present beginning about 1905. In J. E. Stout's report, "Development of High School Curriculum in the North Central States from 1860-1918," published by the

2 Roecker, W. F., "An Elementary Course in General Science," in School Science and Mathematics, 14:755-69.

Worun, A. A., "General Science in Michigan," in General Science Quarterly, 2:267-84.

Howe, M. C., "Can and Should General Science be Standardized?" in School Science and Mathematics, 19:248-55.

Miller, C. F., "Survey of General Science Situation in Illinois," in School Science and Mathematics, 19:398-408.

University of Chicago Press, we note that from 1871-1875 about 5% of the schools offered natural science. This was due to Mr. Kiddle, Superintendent of New York City, who had a course of what might be called general science put into their system which was followed by other schools, but it died out as he and those interested in the work left the city schools. In 1884 the United States Bureau of Education sent out a bulletin encouraging science work. Shortly after this and during this time, certain persons were very enthusiastic about special sciences for the grades. Physics was the book used in this grade work more than any other science text. Out of these elementary texts some of the authors got the idea of having several sciences included in one text but it is noticed that they always laid special stress on the particular science in which they were most interested and that was generally the science he taught in college or university. It is on account of such books that the criticism is made that we have no well balanced books. From the beginning of special sciences for the grades we have come all the way to the present texts which have the work just about evenly divided, with special emphasis put on the sciences that explain one's everyday environment. Up to date there have been forty-odd books that have come from the press that have been named general science texts.

It is interesting to note that in the early investigations of general science, the course was not planned for the convenience and need of the pupil but for the convenience and accommodation of the teacher. It was an extra subject that was tacked on to the special science teacher and in some cases given to a teacher that knew very little about any science. These teachers of course would choose the text that fell in their particular line of work, for the physics teacher would select a physics book just as the biology teacher would select a book that had much biology in it. Time has changed this attitude until today we realize that the general science course must be planned to suit the need of the 13- or 14-year-old child and taught by a teacher who can adapt content and procedure to the level of the thinking ability of the boy or girl of that age. It has also become known that many of the special science teachers are poor general science teachers. A teacher must have had some of all the special sciences in order to be a good general science instructor, and we now have some schools that are giving such instruction to prospective general

science teachers. With the last few books published, and the latest instruction given to the teacher concerning general science teaching, the course in general science has become attractive and would hardly be recognized by the teacher of ten years ago.

The U. S. Bureau of Education reported for 1921-22, page 19, upon an investigation which showed the enrollment in different science courses in schools of over 100,000 population. This enrollment is expressed in percentages in Table III.

TABLE III

ENROLLMENT IN CITIES OF 100,000 POPULATION

Science	Percent of H. S. pupils enrolled	Science	Percent of H. S. pupils enrolled
General science	14.84	Hygiene and sanitation	11.71
Physics	8.59	Physiology	4.61
Chemistry	8.88	Physiography	2.68
Biology	8.96	Geology	.17
Zoology	1.23	Agriculture	.27
Botany	2.89	Home economics	12.47
Electricity	.23	Astronomy	.10

TABLE IV

THE CHANGES IN SCIENCE ENROLLMENT IN MINNESOTA FOR THE FIVE-YEAR PERIOD FROM 1915 TO 1920

(+ indicates gain; — indicates loss.)

Subject	Total number students		Percent of total enrollment		Percent of gain or loss
1915-1920	1915	1920	1915	1920	in 5 yrs.
General Science	458	5684	1.2	11.5	+858.3
Physics	3865	3835	10.0	7.8	—22.0
Chemistry	4293	4790	11.0	9.7	—11.8
Biology	675	889	1.7	1.8	+6.0
Zoology	2275	1450	6.0	2.9	—52.0
Botany	3981	3072	10.0	6.2	—38.0
Physiology	3095	3082	7.5	6.3	—16.0
Physical Geography	3264	2092	8.0	4.2	—47.5
Total in State	39520	49060		Percent gain	24.1

In *School and Society*, 16: 367-71, James and Wipperman have an article on, "Science in Wisconsin High Schools." They obtained the data shown in Table V from 100 high schools giving a four-year course, 50 of which represented Agricultural High Schools and 50 non-Agricultural High Schools. It was found that the special sciences ranked a little higher in the agricultural schools than in the others. The data are given in percent and one can readily see that since most high schools require 16 credits for graduation, a percentage of 6.25 will represent one credit. If a subject has 6.25 percent, it means that it must have been required.

TABLE V

SUBJECT ENROLLMENTS IN 100 WISCONSIN HIGH SCHOOLS BY PERCENTAGES

Science	1901	1911	1921
	%	%	%
General Science	.00	1.11	5.65
Physics	2.94	3.56	2.78
Chemistry	.20	.86	1.69
Biology	.00	.00	1.54
Zoology	.31	.26	.24
Botany	4.49	3.38	.87
Physiology	4.18	3.40	1.79
Physical Geography	6.25	4.39	.48
Total Sciences	18.37	16.96	15.04

LOSSES	%	GAINS	%
General Science	5.65	Physical Geography	5.77
Biology	1.54	Botany	3.62
Chemistry	1.49	Physiology	2.39

Dr. Stout of Northwestern University chose forty schools which represented the states of South Dakota, Ohio, Michigan, Missouri, Illinois, Indiana, Nebraska, Kansas, and Iowa. He compared the subjects offered from 1906-11 with those offered from 1915-18. Table VI indicates the number of the forty schools offering these sciences.

TABLE VI

SCIENCES OFFERED IN FORTY SCHOOLS THAT STOUT INVESTIGATED

Subject	1906-11		%	1915-18		%
General Science	1	or	2.5	19	or	47.5
Physics	40	or	100.0	40	or	100.0
Chemistry	37	or	92.5	37	or	92.5
Biology[3]	7	or	17.5	18	or	45.0
Zoology	22	or	55.0	16	or	40.0
Botany	34	or	85.0	27	or	67.5
Physiology	26	or	65.0	21	or	52.5
Physical Geography	33	or	82.5	21	or	52.5
Astronomy	5	or	12.5	1	or	2.5
Geology	4	or	10.0	3	or	7.5

The writer of this article thought that Dr. Stout's investigation ought to be carried on to the present date. **On Nov. 28, 1924,** therefore, a letter was written to the same forty schools asking for the enrollment in the sciences mentioned above. The enrollments include only senior high schools or regular high school students. Those offering the courses include junior high school data only if such data were voluntarily given for the letter did not call for such data.

TABLE VII

1924 ENROLLMENT IN 34 OF THE 40 SCHOOLS IN STOUT'S INVESTIGATION

Subject	Enrollment	Number of schools offering the course		
General Science[4]	3172	30	or	88.2%
Physics	2918	34	or	100.0%
Chemistry	2729	33	or	97.0%
Biology	2876	25	or	73.5%
Zoology	357	6	or	17.6%
Botany	743	13	or	38.2%
Physiology	760	16	or	47.0%
Physical Geography	1071	12	or	35.2%
Astronomy	0	0	or	.0%
Geology	0	0	or	.0%

3 Biology became a high school subject between 1896-1900.

4 In response to the question, "Is general science required?" 12 answered yes, and 21 answered no.

TABLE VIII

SUMMARY OF FORTY SCHOOLS, COVERING DR. STOUT'S WORK AND THE LATER INVESTIGATION

(The table gives the percent of the schools offering the different sciences.)

Subject	1906-11	1915-18	1924
General Science	2.5	47.5	88.2
Physics	100.0	100.0	100.0
Chemistry	92.5	92.5	97.0
Biology	17.5	45.0	73.5
Zoology	55.0	40.0	17.6
Botany	85.0	67.5	38.2
Physiology	65.0	52.5	47.0
Physical Geography	82.5	52.5	35.2
Astronomy	12.5	2.5	.0
Geology	10.0	7.5	.0

GAINS IN PERCENT		LOSSES IN PERCENT	
General Science	85.7	Zoology	37.4
Chemistry	4.5	Botany	46.8
Biology	56.0	Physiology	18.0
		Physical Geography	47.3

LOST AS HIGH SCHOOL SUBJECTS IN 1924

Astronomy

Geology

In glancing at the tables it is interesting to note that general science is now the most widely taught science in our curriculum. It has gained rapidly and its gain can be accounted for in the losses chiefly of physical geography and physiology. Biology has made rapid progress in becoming established as a high school subject, but its gain has not been as rapid as that of general science. The gain in biology is mostly responsible for the losses in botany and zoology and somewhat in physiology. Zoology and botany have dwindled down rapidly except in the larger schools where it seems to be more convenient to teach them than biology. In some cases, however, it is because they offer more specialized courses.

General Science has been taught in the ninth grade more than in any other grade because it had its beginning in the 8-4 plan and most of the schools are still running under that plan. Where the junior high school plan has been adopted, we find that the eighth grade is the best year for introducing general science. In Kiang's investigation in which 117 teachers designated where general science should be taught, 55 indicated eighth grade, 47 indicated ninth grade and 15 indicated seventh grade.

THE ANALYSIS OF SUBJECT MATTER IN TEXT BOOKS

In the analysis representative books were analyzed and in each subject the pages were averaged so that we might know the contents of an average book. These average books were used in the final articulation of the subject matter. This articulation contains 861 topics. Lack of space does not permit the printing of individual tables for each science or the articulation. Samples of two special science tables and the articulation will be given in Table IX so that it may be clear how the results were obtained.

THE ANALYSIS

The letters A. B. C., etc., represent different texts in the subject analysis, and in the articulation they represent the different sciences, physics, chemistry, biology, zoology, botany, physiology, physical geography, and general science. The data under these letters give the number of pages on each topic listed in the respective books. The last column in each table shows the average number of pages for each topic in the different sciences which are used in the articulation of the subject matter.

TABLE IX

1. BIOLOGY

Topic	A	B	C	D	E	Av. pages
Absorption	1	2¼	¾	1½	3	1,7
Alimentary canal	6	4	5½	4¾	4	4.9
Amœba	1	3	2	3¼	.	1.9
Ants	.	2	1	.	1	.8

2. GENERAL SCIENCE

Topic	A	B	C	D	E	F	G	H	I	J	K	Avge. Pages
Air	3½	–	¼	7	–	3	3	3¼	1¾	3½	2½	2.52
Air Composition	–	3	–	1	1½	1¼	½	¼	–	½	3	1.
Air Pressure	8½	7	10	4	3	5	3	3½	2	5¾	3½	5.02
Alimentary Canal	1	–	1	–	1	¼	1¼	–	–	–	–	.44

3. THE ARTICULATION OF SUBJECT MATTER

Topic	A	B	C	D	E	F	G	H
Absorbtion, foods	—	—	1.7	—	—	3.	—	.04
Air Pressure	24.2	—	.2	—	—	—	4.	5.02
Alcohol	—	2.7	13.7	—	—	7.3	—	1.94
Alimentary canal	—	—	4.9	—	—	3.5	—	.44
Bacteria	—	—	7.6	1.1	10.2	—	—	7.5

4. SUMMARY OF THE ARTICULATION

SCIENCE	Pages in ave. text	Pages of ave. Gen. Sc. falling under	Per cent of ave. Gen. Sc. falling under	Per cent of ave. Special Sc. covered by ave. Gen. Sc. text
Physics	427.39	177.32	32.4%	41.4%
Chemistry	417.5	104.38	19.1%	25.0%
Biology	446.7	154.52	28.3%	34.5%
Zoology	422.6	32.79	6.0%	7.7%
Botany	453.4	78.69	14.4%	17.3%
Physiology	363.5	74.57	13.6%	20.5%
Physical Geography	415.7	119.47	21.8%	28.7%
General Science	546.13			
Total		741.74		

The total pages of general science listed under all the topics when checked with each special science separately are 741.74. The average general science text only contains 546.13 pages. This means that 741.74 pages minus 546.13 pages give 195.61 pages that must overlap in two or more subjects. There are 93.92 pages of biology that overlap with zoology and botany as one would expect. There are 60.54 pages of biology that overlap with physiology, and 18.06 pages of physics that overlap with chemistry. Only 23.09 pages remain to be accounted for in the overlapping which may take place in the remaining sixteen ways that the special sciences may be paired.

Since we know the number of pages of general science that fall under each special science, we can in the third column express the percent of general science that is each of the special sciences. Assuming that a page of general science is equivalent to a page in the special sciences, we can in the last column express the percent of the special science that is covered by the average general science text.

THE CONCLUSION

General science is now required in many of the schools. Most states require physiology and hygiene to be taught but these re-

quirements are being fulfilled in many places by a portion of general science or biology. The average general science text contains 74.57 pages of physiology and hygiene. The average biology text contains 60.54 pages of physiology. These pages are sufficient to meet the state requirements when taught with the related topics on community life found in either the general science or biology texts.

General science should be required of every pupil going through the ninth grade of the high school. Should the pupil drop out of school following the ninth grade or take no more science during his high school course, he has at least had the fundamental principles dealing with his environment and has gained valuable knowledge concerning nature, himself, the home, the community, and some of the industries where he finds employment. No other subject can give the boy or girl who quits school as much usable knowledge as general science in the time that is given to its teaching. On the other hand, should the pupil continue through the high school, he will have the elementary fundamentals of the special sciences and can continue in biology, chemistry, and physics just where he quit in the general science. By this articulation the student will complete more work in these special sciences, and at the same time through the general science get all the fundamentals, principles, and facts in physiology and physical geography that a person will retain and use. Much of physical geography is not interesting to the student as he feels no need for it in life. The important things, such as the atmosphere, weather, storms, erosion, etc., are found in the general science books.

The trouble with the science course in the high school today is simple. In most cases the sequence of subjects is worked out but the teachers do not know exactly what has been taught the pupils before they come to the special science classes. Each teacher begins, therefore, with the preliminary things, generally to accommodate a few who did not have general science where those things were taught. According to the articulation of subject matter, the majority of the class who took general science will shirk on the job for they have already had 34.5% of the biology, 25% of the chemistry, and 41.4% of the physics that is being offered by the teacher. That is enough to make many of our best students lazy and careless and it is because of this lack of articulation that spoils the interest of many students. This explains why many

general science students do poorer work in the special sciences than those never taking general science. The subject is taught for the interest of the non-general science pupil.

If the school system is on the 8-4 plan, then general science should be taught in the ninth grade of the high school. In most cases where general science is taught in the eighth grade under that plan it is poorly taught, because the teacher is not prepared to teach it and therefore the pupils get very little out of the course. They will have to take it again in the high school.

In the junior high school, general science may be offered in the eighth or ninth grade. Experiments by H. A. Webb prove that the seventh grade child is not able to grasp many of the principles of science and cannot reason well enough to solve many of the problems involved. Being in the junior high school, the equipment and teacher ought to be adequate to teach the subject. Where general science is offered only two or three times a week, very little is accomplished. The interval of two or three days between recitations loses many of the facts gained in the previous lesson and to get their connection, part of the following period must be used to bring them back. Such an arrangement cannot be considered a good course, although the subject may run over a period of two years.

The ideal plan under the 8-4 plan would be to give general science in the ninth grade, biology in the tenth, and physics and chemistry the last two years, preferably chemistry first. General science should be required. Then those electing any or all of the special sciences can continue where they left off in the general science and thus cover far more work than under the old plan where every science is taught separately as a unit by itself.

In the junior high school system, general science should be taught in the eighth or ninth grade. If taught in the eighth, biology may follow in the ninth. The tenth grade will be vacant as far as science is concerned, thus giving a year for other work. The last two years should again be given to chemistry and physics. It is best to follow general science at once with biology if it is to be given.

If there are still some schools that do not give the general science course, then of course physiology must be taught. A whole year will hardly be necessary, so the best plan is to teach physiology one-half of the year and during the other half teach physical

geography. A half year is sufficient time to cover either one of the subjects. Biology, chemistry and physics may follow, but under this plan no introductory work has been given in these subjects, so each has to be taught from the beginning. Under the general science plan, the time spent on preliminary topics can be used on advanced work.

The biology, chemistry, and physics texts today contain so many facts that it is hard to complete them in one year. It is easier to omit some topic in biology and in chemistry than in physics. In physics the facts stand out so conspicuously that it is hard to omit them without someone's noticing it. With the new developments of the automobile, airplane, radio, and others, it is very hard to cover every topic as the text is getting too large. Taking the elementary principles in general science allows plenty of time to cover all the topics thoroughly in the physics course. The same is true of the biology, but it is a comparatively new subject and should a teacher omit part of the work it would probably pass unnoticed. In this conclusion the term biology may in a few cases be interpreted zoology and botany, but in most cases biology is meant. One year of biology is a far better course than one-half year of zoology and the other half botany.

It will probably be a long time before there will be a standard course in general science. The chemistry course, although belonging to an old science, has not yet been standardized. In that same sense there will probably never be a standard course in general science, although in the analysis one finds that the recent books contain closely related topics and thus approach nearer a standard course. From experience it may be known that the course will never be uniform because the different sections of the country and city will put emphasis on different topics. However, each school should have a well-outlined science course that runs through the high school. It should not only arrange the sequence of science subjects but arrange a sequence of the content that is to be offered in the high school, if the course is to be good. The recent check on the curricula shows the sequence of the subjects to be quite definite in part of the schools. General science has made rapid progress as a course so that now it is offered in practically every school. If it is not offered in the high school, it is offered in the junior high school or the grades. Biology has grown almost as fast and is now offered in about three-fourths

of the schools. As these two subjects have gained prominent places in the curriculum, physical geography, physiology, zoology and botany have lost their prominence as none of these is now offered in half of the schools. Reference to the tables will give their exact standing. Some of the schools have passed through the transition period and discarded the physical geography, zoology, botany, and physiology courses. Others are in the transition period and are really teaching both systems. A few adhere to the old system of science teaching. General science has had a good beginning and as it is nearing a standard course, in a few years it should convince even conservative people exactly where it belongs in the curriculum.

The Captain's Compass

O. E. UNDERHILL, High School, Amesbury, Mass.

IN TWO SCENES.

Characters

The Captain—captain of an ocean liner.
John—the captain's nephew.
The teacher—science teacher in the school where John attends.
The Helmsman.

Mary—, Charles—, Alice—, Frank— } Boys and girls in the class.

Scene one—The pilot-house of an ocean liner.
Scene two—The class room.

Scene 1. The pilot house of an ocean liner. Doors open right, left and center. The Helmsman is at the wheel staring ahead through the glass of the pilot-house, occasionally glancing at the compass in the binnacle. (In a school room a window may conveniently be used as the front of the pilot-house, and a pedestal arranged for a binnacle. A clock, barometer and map, etc., may be hung around for effect.)

The Captain enters accompanied by his nephew.

Capt. And this is the place from which I direct the ship. Here I am in touch with all parts of the ship by means of telephone,

speaking tubes, and signals. I am in direct communication with the engine room by means of these levers here. With them I signal the engineer what to do. The Helmsman is there at the wheel steering the ship.

John (pointing to the binnacle). What is this?

Capt. That is the binnacle. It carries the compass.

John. What is it for?

Capt. Why, John, you don't mean to tell me that you do not know what a compass is for?

John. It tells in what direction the ship is going, doesn't it?

Capt. Yes, that is it. (Speaks to the helmsman) Steer a few points off the course so that the boy may see how the compass acts.

Helmsman. Yes, sir. (After a few minutes) We are now north by east, sir.

John. Oh! the dial turns around. I thought that in a compass a needle turned and pointed towards the north. I don't see any needle there.

Capt. A land compass does act that way. In a marine compass the card turns instead. See, the northeast by east point on the card is opposite the line on the bowl of the compass. That means that the keel of the ship is in line with that mark and the point indicated by the compass card. (Speaks to the helmsman) Bring her on the course again. Where are we now?

The Helmsman (indicating on map). About here, sir.

Capt. (after consulting map, speaks to John). Now we should be making north, northeast. The helmsman will now swing the ship around until the north, northeast point on the card comes opposite that line, which is called the lubber's point.

The Helmsman. We are now north, northeast, sir.

John. What makes the card move?

Capt. There are a number of magnetized needles hung underneath the card. They always point toward the north. The card is floating in water so that though the ship turns the card always lies in the same position.

John. Doesn't it ever freeze?

Capt. Alcohol is put into the water to keep it from freezing, just as your father puts alcohol into the radiator of his car for the same purpose.

John. What are these iron spheres for?

Capt. The iron in the ship attracts the compass needles and

makes them point away from the north. Those balls of iron are placed so as to counteract the effect of iron in the ship. There are bars of iron inside that you cannot see. There are many things which influence to make the reading not quite right so we must take observations of the sun or stars every day in order to keep track of how our compass is behaving. Then, when it is cloudy and we must go by the compass, we know how to correct its errors.

John. It always stays level, doesn't it?

Capt. It is set on a ring and balanced so that no matter how the ship rolls the bowl will always remain level. The water on which the card floats helps to take up the vibrations caused by the engines. I must be busy for a while now. Come up again in about an hour and I will take you to the engine room and show you the engines.

John. Thank you, sir. (*Exit.*)

End of scene one.

SCENE 2

A classroom. The class is in order and the teacher is presiding.

Teacher. Can any of you tell me anything about a compass?

John. I went away on a ship last summer and the captain showed me all about the ship. He showed me the compass they used to steer by and told me about it.

Charles. My father is a surveyor and he uses a compass.

Teacher. John, tell us about the compass *you* saw.

John. It isn't at all like the compasses the boys in the scout troop have. You can't see any needle at all. The whole dial turns around so that the north point on the dial always is toward the north no matter which way the ship points.

Mary. How can it stay one way if the ship turns? I should think the compass would have to turn with the ship.

John. It floats in a bowl of water.

Teacher. Could you show us with a bowl and a card? (The teacher provides a piece of cardboard and a bowl of water. John cuts the cardboard into a circle a little smaller than the bowl, makes a pencil mark at a point on the circumference, places a block of wood beside the bowl so that the top face of the block is level with the top of the bowl, and makes a pencil mark on the block of wood. He then puts the pencil mark on the card (the card floating on the water) opposite the mark on the block of

wood and shows that even though the bowl is turned completely around, the card remains stationary, the pencil mark pointing to the one on the block.)

Mary. Oh, I see now.

John. If we had some magnetic needles we might be able to fix them up on the card so that it would always point north.

Teacher. I have some knitting needles and a magnet. Perhaps we could fix it.

Alice. Oh, let's try it.

(The teacher gets knitting needles and cuts them in two with pliers, making four steel bars about four inches long.)

Teacher. Here are some bar magnets. Notice one end is marked "N." That means that if we hang it balanced in the middle the end marked "N" will point towards the north. (This might be done if a stirrup for holding the magnet is available, or may be made from wire.) Now four of you each take a piece of knitting needle and one of these magnets. Stroke the needle with one end of your magnet, always in the same direction. (The teacher sees that each is working correctly in order to magnetize the needle.) Frank, you are a boy scout, are you not? Have you your compass with you?

Frank. Yes, here it is.

Teacher. Thank you, Frank. In what direction is North?

Frank. The sun sets there (pointing to west) so north must be there (points to north).

Teacher. Yes. And you see that is the direction in which the blue end of this compass needle points, so the blue end must be the north pole. Now notice what happens when I put the end of a magnet marked "N" near the blue end of the compass needle.

Mary. The magnet pushes the blue end right away. It attracts the other end. (The teacher turns the magnet around.) And the other end of the magnet attracts the blue end of the needle.

Teacher. We say, then, that unlike poles attract each other and like poles repel each other. Now the needles are all ready. How shall we put them on the card, John? Shall we lay them on anyway?

John. All the north ends must be pointing the same way.

Teacher. Mary, take Frank's compass and find out which ends of these needles are the north ends.

(Mary takes the needles, tests them with the compass, and lays them with the north ends together.

Teacher. Here is a needle and some thread. Mary, fasten them to the card by making little loops of the thread. Put two each side of the center and be sure that all the north ends point in the same direction. Now, James, you may take the card and mark it like Frank's compass. Make sure that the point you mark north is at the side of the circumference to which the north ends of the needles point. We had better coat it with paraffin, too, so that the card will not become soaked.

(The card is marked, a dish of paraffin melted, the needles sewed on, and the whole brushed with the hot wax. During this time as much of the theory of magnetism may be brought in as is desired by the teacher.)

Teacher. Now our compass is all ready. Let us try it. (The card is floated on the water, and turns so that the "N" of the card points to the north.)

Alice. Let us make a ship and sail it around the room.

Mary. We can use this chair for a ship.

John. What will we do for a binnacle?

Mary. What is a binnacle?

John. It is the stand that the ship's compass is mounted in.

Teacher. Here is a box that may do.

John. I will stick a paper label on the inside of the bowl and mark a line on it. It is supposed to be in line with the keel of the ship. My uncle says it is called the Lubber's point.

Mary. What course will we steer?

Charles. Let us map out our course first. Can we not let the floor of the room represent the ocean and the tables and chairs continents or islands?

Teacher. Here is a map of the United States. Let us start from Boston, and take a trip to New Orleans, stopping off at Havana on the way.

(Children study the map, locating the cities named.)

We will call the east side of the room the Atlantic ocean. This desk second from the back of the room in the first row we will call Boston. I will place this table at the first desk in the room, sticking out into the room to represent Florida. This first desk in the fourth row will represent New Orleans. I will pull my desk to one side here for Cuba, and these chairs may represent

Haiti, Jamaica and others of the West Indies. Now plan your course.

John. We must sail east from Boston to get out around Cape Cod. Then sail south down the coast.

Alice (studying the map). Then we must swing to the west around the point of Florida and then to the southwest to touch at Havana. Then we go northwest to New Orleans.

Teacher. We are ready to sail, then. John, you may be captain of the ship. Take the chart and call the course. Charles, you may be helmsman and steer the ship.

(Charles grasps the back of the chair on which is the improvised binnacle and compass, pushes it up to the desk representing Boston, heads the chair east and turns the binnacle until the lubber's point is east. The north on the compass card should then be pointing to the north or back wall of the room, and the east on the card should be opposite the line drawn on the side of the bowl.)

John (calling the course; Charles pushing the chair and turning it so that the points as called by John are opposite the "Lubber's Point"). All ashore—start your engines—half speed ahead—hold her due east—full speed ahead—now we are off—two points to the south—now we are rounding Cape Cod—bring her due south, helmsman—now we are passing New York—the Delaware river—Cape Hatteras—steer southwest by south—we must get in a bit closer so as to pass between Florida and the Bahamas; there is a big bank there and we must not run on to it—now south by east around the point of Florida—now west a few points—hold southwest by south until we reach Havana. We can only stop to take on a few provisions. Now we are off again, Steer northwest by west and hold it until we make New Orleans.

Teacher. That certainly was a speedy voyage. I know you must have a lot of questions to ask about the compass, but it is so late now we will be obliged to leave them until tomorrow. Find out all you can about the subject and we will discuss it then.

End of scene two.

NOTE. For further work a surveyor's compass might be discussed in much the same manner. A plot of land could be laid out in the school yard, using such a compass. Then the whole theory of the earth's magnetism and the resulting action of a compass needle might be discussed. Perhaps the new gyroscopic

compass might be mentioned, which is non-magnetic and points to the true north, with much more force than the strongest magnetic compass. While the theory of the precessional forces is too advanced for young pupils, if a toy gyroscope is at hand it is easily shown that it resists attempts to move it in certain directions. Then it might be briefly explained that the rotation of the earth tends to move the gyroscope but it resists the motion and by suspending it a certain way it will always point to the north. I think that young pupils should be given an idea that there is such a thing, as some of the United States battleships have already adopted this compass and it will undoubtedly be used universally in time as it is entirely independent of the magnetic effects of iron ships which causes so much trouble now.

Keeping Abreast the Times in General Science Classes

Dennis C. Haley, Teachers College of the City of Boston.

Consider, for a moment, some of the wonderful strides that were made in the field of science during the year 1924. At the McCormick Institute of Infectious Disease, Drs. George and Gladys Dick discovered the cause of and devised a cure for scarlet fever. There are reports that the attempt of the mediæval or alchemists to produce gold from a base or cheaper metal, was partially accomplished by certain German chemists. The United States army aviators succeeded in accomplishing via air, in a comparatively short time, what it took Magellan in the sixteenth century about three years to accomplish by a water route. Photgraphs were sent both by wire and by radio. Certain members of the extensively advertised and extremely elusive food factors, vitamins, were isolated. Wonderful and almost unbelievable accomplishments were brought about by the mysterious ultra-violet rays. These are only a few of the important advances of the past year that mark the rapid development of science. The newspapers in their broadcasts are featuring all of these wonders and our pupils are coming to class demanding of us some sort of explanation for the novelty. We must in some way satisfy their inquisitive minds if we are to maintain their interest in us and in the work in General Science.

The writer feels that the best way to give General Science pupils some understanding of these great scientific discoveries is by means of a simple experiment. It is true, of course, that many of these accomplishments are so difficult and so complicated that no simple experiment can be devised to explain them. However, if it is at all possible, this method of explanation should be used. With this in mind the writer has selected as a topic, "The Possibilities of the Ultra-Violet Ray." An attempt has been made to show how this topic, typical of the many scientific advances during 1924, can be presented and explained to the average Junior High School class. The facts mentioned are simple and within their grasp. The experiment suggested is practical and can be done in any classroom.

A brief summary of what has been accomplished by expert scientists experimenting with ultra-violet rays follows. This summary might well be told to a class in a clear and elementary manner. It will arouse their interest and motivate the experiment that is to follow.

Dr. C. C. Little, President of Maine University, and Professor Bovie of the Harvard Medical School have been doing a great deal of research work with ultra-violet rays. Through their experiments and study we are led to believe that ultra-violet rays can be used to prevent and even cure rickets, that they can probably be used to cure boils and some kinds of asthma, to tighten teeth, to make broken bones mend more quickly, to cure convulsions, tonsilitis, rheumatic affections, and even tuberculosis in its earlier stages.

Dr. Steenbock, working at the University of Wisconsin, experimented with young rats. He divided a given number of rats into two groups. To one group he fed food that contained no vitamins. To the second group he fed the same diet after it had been exposed for ten minutes each day to the action of the ultra-violet rays. At the end of a month he found that the individuals in the second group weighed twice as much as those of the first group. When he killed them and analyzed their bones he found that the rats in the second group had bones that were well formed and contained a sufficient amount of mineral matter. From these experiments we are led to believe that there is a direct connection between ultra-violet rays and vitamins, since vitamins are so essential to the proper formation and development of the bones.

Class Demonstration

To give a class some idea of what ultra-violet rays are, the following experiment is suggested.

Hold a glass prism in such a position that a beam of sunlight will pass through the prism. Observe the beautiful rainbow effect on the opposite wall. Where have you seen a similar phenomenon in nature? What colors can you distinguish Examine these colors carefully.

This experiment shows that white light is really a combination of the colors that are seen on the wall. The red color (pupil should point to this color in the spectrum) is due to long light waves. Waves just a little shorter cause the indigo. Waves much shorter still cause the color that we call violet. There are waves even shorter than these violet waves that the human eye cannot see. These are the ultra-violet rays. (At this point the teacher should point to the area on the wall just outside of the violet color. This is the region of the ultra-violet rays but they are too short to produce any sensation of color to the human eye.)

This experiment will naturally lead to the question of how these rays can be produced. These rays come to us in ordinary sunlight but glass does not allow them to pass through it. Glass allows the longer color waves to pass through it but it filters the short ultra-violet rays. Recently the General Electric Company has produced a fused quartz substance which will allow these short ultra-violet waves to pass through it. To obtain the ultra-violet rays, then, an artificial sunlight lamp is used. This is similar to the bluish mercury lamp seen in photographers' windows. Instead of using a long glass tube, however, as is used in the photographer's lamp, a tube made of fused quartz is used. The artificial sunlight lamp or mercurial lamp emits the ultra-violet rays along with the other rays and the fused quartz allows them to pass through it into the space surrounding the lamp. In this way ultra-violet rays are produced for experimentation and for practical applications.

This experiment and explanation should give the pupil a good understanding of the use of these short invisible rays of light, of their future possibilities, of where they exist, and of how they may be produced artificially. This information should enable and encourage him to keep up with the advancements on this topic by

contacts with newspaper articles, pamphlets, and magazines. It should help to broaden his whole horizon and attitude toward daily advancements in the whole field of science.

Clear Fused Quartz[1]

A new aid to men of science which may well develop into one of the most signal contributions of the century is contained in the fact that clear fused quartz can now be produced in large quantities and in relatively large masses.

PHYSICAL PROPERTIES OF CLEAR FUSED QUARTZ.

Specific gravity is 2.21.

Co-efficient of thermal expansion is 58x10-8 (about 1/17 that of platinum, and 1/34 that of copper).

Index of refraction for the D line is 1.459.

A rod one meter long will emit at one end about 93% of the light passed into the other end.

The ordinary run of clear fused quartz will transmit wave lengths as low as the 1850 A line in the ultra violet. Heat rays are also transmitted, with little loss.

Probably the two most important properties of this substance are: first, its ability to transmit wave-lengths which cover a wide range in the spectrum, ranging from the infra-red or heat rays, through the various colors visible to the human eye and on down to those shorter wave-lengths known as ultra-violet, invisible, but health-giving; and second, an extremely low co-efficient of thermal expansion.

Because of its ability to transmit visible and invisible rays, around curves if necessary and with little loss, this material will be of great benefit in therapeutics. Because of its low co-efficient of thermal expansion, precision apparatus, the tools with which science works, will be increased in accuracy and utilized in new ways which will add to the sum total of human knowledge.

EXAMINING LIVING TISSUE.

In using the microscope for examining cell structure in biological work, it is often necessary to stain the slides in order to bring out the cell's construction. Sometimes the process of staining

1 By courtesy of "Transactions of Illuminating Engineering Society" (July, 1924).

changes the actual character of the cell, certainly it injects an element foreign to its nature. Using a clear fused quartz lens, and ultra-violet light, a photograph can be taken of the cell-photographic plates being affected by ultra-violet although it is invisible to the human eye. It is quite possible that the resultant knowledge of cell tissue will be new and valuable, perhaps startling.

IN PRECISION INSTRUMENTS.

The standard of length, housed in the Bureau of Standards is a meter bar, with two studs inserted marking off the international unit of measurement, 100 centimeters. Great precautions are taken to keep this standard of length at constant temperature. A rod of fused quartz one meter long will expand about six-tenths of a millimeter for a temperature increase of 1000 degrees Centigrade. This remarkably low co-efficient of thermal expansion may also be utilized in the construction of pendulums of clocks, where a change in length must be compensated.

A thermometer made from quartz is not subject to the appreciable "lag" known to exist in glass thermometers. When a mercury-in-glass thermometer and a mercury-in-quartz thermometer were placed in a bath of melting ice (zero degrees Centigrade) and the temperature raised to 515 degrees Centigrade, then slowly lowered to zero, the glass instrument read four degrees below zero while the quartz instrument read zero exactly. Clinical thermometers are also subject to this discrepancy, and where a difference of a half-degree is of incalculable value to the physician, quartz may replace ordinary glass.

Clear fused quartz may find a field of usefulness in the musical world. A tuning fork made from this material does not change its pitch with temperature changes. It may be corrected in manufacture without having its pitch appreciably affected by an increase of temperature due to grinding or otherwise working the material as is the case with metallic forks.

IN THE MEDICAL FIELD.

For therapeutic treatments quartz seems to offer valuable contributions. It is possible to localize and direct rays of ultra-violet[2] light by the use of a quartz rod. This rod being curved into the the necessary shape the light is transmitted into the body cavities

2 The "observed" ultra-violet rays range from 202 engstroms to the last visible violet, 2,600 engstroms. The engstrom is a unit of light measurement and is 10-8 centimeters.

which have hitherto been inaccessible or difficult of access. Ultra-violet light, produced by a mercury-vapor lamp also constructed of quartz, is used as the source of the rays.

Water is sterilized when subject to these rays. Due to the absorption by the atmosphere, comparatively few ultra-violet rays from the sun reach the earth. It is now possible to obtain and direct ultra-violet light from quartz mercury-vapor lamps, and to send it around corners.

IN ASTRONOMY AND PHOTOGRAPHY.

Since the image of a star is always a point on the axis of a lens, the axial aberration is of chief importance in astronomical work. In photographic lenses, however, it is necessary to recognize and correct for five different kinds of spherical aberration, and the manufacture of high grade photographic and astronomical lenses has been increasingly complicated.

For accurate work in astronomy it is vital that the huge reflectors (mirrors) and lenses maintain a constant temperature during observations. To achieve this, elaborate precautions are necessary whereby constant temperature vaults are provided whose temperatures are maintained by the circulation of brine in pipes, and even then the mirrors are "put to bed" under many layers of blankets in order that the temperature changes may be evenly maintained. All of these precautions are taken to avoid the distortion which would follow a temperature change in any one section of the lens resulting in internal stresses. The low co-efficient of thermal expansion, again reverting to the second mentioned notable property of clear fused quartz will perhaps do away with these precautions. A telescopic mirror or lens made from quartz would certainly go through a range of temperature changes without distortion of the image. Add to this the fact that clear fused quartz can now be produced in relatively large masses; that the supply of raw quartz constitutes no less than three-fifths of the earth's surface (considered to be ten miles deep) and the more apparent applications are accounted for.

Glass condenser lenses for use in the larger motion picture machines have a comparatively short life, often breaking in a day or two. Frequently these lenses are subjected to the heat of an arc consuming 150 amperes of current. Quartz lenses have been operated in motion picture projectors for six to eight months and are still intact. These lenses are also more free from pitting

deposits which result from hot particles thrown while molten from the carbon.

The paper delivered by Edward R. Berry before the forty-fifth annual meeting of the American Electro-Chemical Society, at Philadelphia says, in part:

"It has been possible for many years to make fused quartz of a high quality in small sections and lengths by hand labor in the ordinary blast flame, using gas and oxygen. This has been done by piecing together small sections of crystal in the flame, or by adding silica powder from time to time until the piece has grown to the heating limit of the flame; an obviously slow and expensive process. From this step in the development of the art to the point where very large masses of equal quality can be made has been long and difficult.

"In the last few years the advances made by the process described in this paper have been so rapid and far-reaching that there seems to be no limit now to the size of high quality clear fused quartz which can be made, except that which may be imposed by mechanical difficulties.

"There are two distinct steps in the preparation of these tubes, rods, ribbons and cane; the most important of which is the initial fusion. The clean quartz crystals, which are of various sizes, are packed as densely as possible in a graphite or carbon crucible so that during the cracking of the crystals, which is bound to occur as the temperature is raised, the parts cannot separate and allow any small amount of gas which may be present to enter the many crevices and thus form bubbles. These tightly packed crucibles are placed in a modified vacuum furnace and the temperature raised as quickly as possible to the melting point. During this fusion the pressure in the furnace is kept as low as possible. The time required for fusion will vary, of course, with the conditions and in all cases no more than 45 minutes is necessary. The energy rate of fusion is from 3 to 8 kilowatt-hours per pound of quartz, and the loss of quartz due to volatilization is neglible compared with other charges. The result of this first fusion is a clear, transparent slug containing comparatively few bubbles ranging in size from a pin point to 2 or 3 mm. in diameter. Whether these bubbles have been formed by a gas or by silica vapor, it must be remembered that they have been formed at a temperature of about 1800° C; and consequently their pressure at room temperature is very small. This slug is now placed in another graphite crucible

which is suspended in a vertical carbon tube furnace. A graphite piston which just fits the crucible is placed on top of the fused quartz slugs and a weight is placed on top of a plunger attached to the piston. The slugs are again brought to a fusion, the bubbles are largely collapsed and by the action of the weight, the quartz is extruded in the various forms, such as rods, tubes, ribbon, etc., which are shown. This material is practically free from bubbles, but because of limiting dimensions it may become necessary to rework some of this, which is accomplished by the usual bench methods with an oxygen-illuminating gas flame.

"When it is desired to obtain large blocks as free from bubbles as the tubing, cane and ribbon, another operation is necessary. As before, the quartz is fused in a vacuum furnace which, however, is also designed to withstand very high pressures. As soon as the material is fused the vacuum valve is closed and the pressure in the tank is now brought up to a pressure, depending on the object in view, in less than a minute. This pressure collapses the bubbles and makes it possible to obtain very large slugs freer from bubbles than many kinds of the best optical glass.

"Previous attempts to reduce the bubbles by continued heating above the melting point resulted, after a certain stage, only in excessive loss of silica by volatilization. We have fused quartz at initial pressures of 600 lbs. per sq. in. atmospheric pressure, and less than 1/2 mm. of pressure. In the first case the mass was practically opaque; at atmospheric pressure it was considerably improved although much inferior to the present quality of quartz; and under vacuum conditions a large mass can be produced, as you can see, which from the standpoint of number of bubbles is very satisfactory.

"Not the least of the difficulties encountered in this development has been that in connection with the furnace equipment. The vacuum furnace in particular had to be greatly changed and enlarged with the result that we now have probably the largest vacuum furnace in daily use capable of operating at low pressures. Then, in addition to this the furnace had to be so constructed as to withstand repeatedly on the cover a total pressure of over 1,000,000 pounds (about 600 tons), and of course as the size of the furnace increases these difficulties are multiplied. Special attention must be paid to the design of resistor unit, to the thermal insulation and even heat distribution—to the cooling of the terminals and many other factors presented in the use of these two extremes in pressure.

"When the quartz crystal is heated between 500° and 600° it undergoes a remarkable physical change, cracking into small pieces sometimes with explosive violence. This is due to the difference of co-efficient of expansion along the two axes, subjecting the crystal thereby to great strain; and because of decrepitation owing to the presence of water and liquid carbon dioxide held in vast numbers of minute cavities throughout the crystal. The only advantage, therefore, in using large crystals for fusing lies in the greater ease of keeping the charge free from foreign material before the different particles begin to coelesce.

"Hereaus has heated crystal quartz in very small pieces, about the size of a nut, very slowly so that no cracking occurs and, consequently, no bubbles are included in the vitreous pieces. Herschkowitsch, on the other hand, has arrived at about the same result by accelerating the heating process so that a film of vitreous material is formed on the outside and prevents air from penetrating to the center, even though cracks may develop. As a matter of fact these processes, while interesting, are subject to very sensitive control and are impractical where large masses are to be fused.

"To obtain masses quite free from bubbles, it has been found best to raise the temperature rapidly to 1400° or 1500° at which point the pieces begin to coalesce. At about 1750° C the quartz viscosity is high even though the temperature be well over 2000° C. Vaporization of fused quartz is rapid at 1600° C and at 1750x C the loss due to evaporation is very great. Further increase in temperature results in no great gain in fluidity.

HOMOGENEITY OF FUSED QUARTZ.

The difficulties of obtaining perfectly homogeneous fused quartz free from striæ, strain, bubbles, and double refraction must be apparent to anyone who has worked on this problem, and discouraging perhaps to those who have tried to buy such material. It is a little too early to state in what quantities such a product can be produced, but we have manufactured quartz of this quality which contained only two or three bubbles visible to the eye. This quality, however, has not as yet been placed on a commercial basis.

The fact that for a great many purposes clear fused quartz can be used up to 1000° C without injury; that its co-efficient of thermal expansion is so small as to make it almost negligible; and that it will transmit light rays even into the extreme ultraviolet with very little absorption, gives to it a great utility value—not only to the scientist but the manufacturer as well.

The Man Who Smoothed the Brow of Agony[1]

"The fierce extremity of suffering of surgery has been steeped in the waters of forgetfulness, and the deepest furrow in the knotted brow of agony has been smoothed forever."

OLIVER WENDELL HOLMES, M. D.

THE Charlton Reunion and Old Home Day Association, in 1919, the centenary year of the birth of Dr. Morton, appointed a committee with power to appoint sub-committees, to erect a permanent memorial at Charlton, Massachusetts, to her honored son, Dr. William Thomas Green Morton, the discoverer of the anesthetic properties of ether.

The dedication took place on September 1st, 1924, and *Oral Hygiene* presents the dedication addresses.

AN ADDRESS BY DR. FRANCIS M. RACKEMANN

The sixteenth day of October is an anniversary of world-wide importance. It is celebrated each year with appropriate exercises at the Massachusetts General Hospital and often in other places. On Ether Day, the former house officers return to Boston and come together once again to show their respect for the hospital where they were trained and show their appreciation of the great discovery which was made by Dr. William Thomas Green Morton, in 1846, within its walls.

The discovery of ether is not only the greatest achievement of the hospital, but it was the first of the really great advances in medical science made during the nineteenth century. And for a time it was the only advance. Pasteur's discovery that germs were the cause of disease did not come until 1870, twenty-four years later, and whereas ether had brought about, as Weir Mitchell puts it, the "Death of Pain," and rendered surgery painless, the discoveries of Pasteur and Lord Lister regarding germs and antiseptics made surgery safe, and none of you need to be told what painless surgery and safe surgery have meant to the world in general, and perhaps to many of you in particular.

Many features of the discovery of ether are worthy of discussion.

Dr. Morton must have been an extraordinary man, and I would call your attention to several features of his life and work which are not ordinarily referred to. For example, is it not remarkable

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1 Reproduced by courtesy of "Oral Hygiene."

that one of the greatest blessings to mankind should have been discovered by a man only twenty-seven years old? In your age of college education and post-graduate study, it is the rule for medical education, at least, to be prolonged until well after the youthful period, and it is to us surprising that such a remarkable and extraordinary advance in our knowledge should have been made after only four years of study. This fact, however, is not without a parallel in our time since, as some of you may know, the discovery of insulin, the new cure for diabetes, was made with the able assistance of a man only twenty-five years old, who has not even yet graduated from Toronto University, but who shares the Nobel prize.

The Tablet bears this inscription: "William T. G. Morton, Dentist, Discoverer of Ether Anesthesia, Notable Contributor to the Advancement of Surgery. First Public Demonstration at the Massachusetts General Hospital, October 16, 1846. Born in Charlton, August 9, 1819. Died in New York, July 15, 1868."

The story of Dr. Morton's early life most of you know. Here in this beautiful country town he was born and here his early life was spent on the farm and in the fields and woods.

We are told that he always wanted to be a doctor, and in studying his early life it is remarkable to see with what persistence and tenacity this desire was maintained in spite of a series of early

misfortunes, and in spite of Dr. Pierce's warning: "Young man, you hardly know what you talk about and how hard I have to work."

How well his early career illustrates the influence of his boyhood environment. Characteristic of the typical New Englander, who must meet and solve by himself the real problems which occur each day, Morton exhibited a rare degree of initiative, intelligence, and especially the quality which has been called stick-to-it-iveness.

Medicine in those early days was learned mainly by apprenticeship to some eminent practitioner. The student of medicine had none of the advantages of hospitals, libraries and well-appointed laboratories which students have today. Preliminary education along general lines was required. This education Morton obtained in country schools and in the academies of surrounding towns.

But there were early misfortunes. We are told that Dr. Morton's school work was interrupted by an unjust punishment. We are told that later his father's business failed and it became necessary for him to stop his studies and go to Boston, where he entered a publishing house to spend his days doing manual labor.

But we learn that during this time his spare moments were put to good account, and his only regret was that the day's work left him with so little time and energy for his books. But note that the idea of studying medicine never left him. Although his success in the publishing business was moderate, he was not happy.

It is surprising, therefore, that we find him at the age of 21 in the new School of Dentistry recently established in Baltimore. Dentistry is first cousin to Medicine. In those days little was known of it, and the suffering from bad teeth must have been considerable. It is not surprising, therefore, that in dentistry Morton should find a suitable outlet for his desire to be of service to mankind.

Now we see the scientific attitude of this young man who was then only 25 years old. Teeth in those days were removed. They were not extracted, but the roots were broken off and left in place, where the diseased process at the bottom could remain active. Think of the ability of the man that he should recognize that these roots must be removed.

But to remove them meant pain and intense suffering to the patient—a stumbling block which simply had to be crossed if success were to follow proper treatment. The use of local appli-

cations in the form of various drugs was not wholly satisfactory, although it helped somewhat.

In the meantime, in 1844, Morton entered the Harvard Medical School where he attended the full course of lectures, and in addition to this school work continued to practice dental surgery and make artificial teeth.

His skill grew. His practice also grew, and if we can believe the story this practice must have been tremendous when materials for making artificial teeth were ordered in hundred pound lots, and the income of his business was measured in thousands of dollars per year. What a contrast this is to the experience of the young man of today two years out of the dental school.

But young Morton clung to his original object. He was determined that tooth roots should be extracted, and extracted painlessly. Ether was one of the drugs which he placed directly on the tooth to deaden the pain, and he was quick to notice that when considerable quantities were used the patient became groggy. This was an important observation, and it was not long before we find him experimenting with it.

I quote from "Trials of a Public Benefactor," written by Dr. Nathan P. Rice in 1859:

"Taking with him a quantity of sulphuric ether, Morton repaired to the country, where, among several experiments which he made with it, the most marked and satisfactory was upon a water spaniel. The ether was poured upon some cotton in the bottom of a tin pan, and the dog's head was held directly over it. In a short time (to use Dr. Morton's words) "the dog wilted completely away" in his hands, and remained insensible to all his efforts to "arouse him by moving or pinching him"; and yet, after the removal of the pan, became in two or three minutes as lively and conscious as ever. Here was the effect sought, and here was demonstrated a complete success."

The next step was to try it on a man—and first on himself. Again I quote from his own description:

"Taking the tube and flask, I shut myself up in my room, seated myself in the operating chair, and commenced inhaling. I found the ether so strong that it partially suffocated me, but produced no decided effect. I then saturated my handkerchief and inhaled it from that. I looked at my watch and soon lost consciousness. As I recovered I felt a numbness in my limbs, with a sensation like

nightmare, and would have given the world for some one to come and arouse me. I thought for a moment that I should die in that state, and the world would only pity or ridicule my folly. At length I felt a slight tingling of the blood in the end of my third finger, and made an effort to touch it with my thumb, but without success. At a second effort I touched it but there seemed to be no sensation. I gradually raised my arm and pinched my thigh, but I could see that sensation was imperfect. I attempted to rise from my chair, but fell back. Gradually I regained power over my limbs, and full consciousness. I immediately looked at my watch, and found that I had been insensible between seven and eight minutes."

Morton was delighted with this experiment. That same day came a Mr. Frost with a severe toothache who wanted to be "mesmerized," but on learning that Morton had something better, quickly submitted to the ether, and the tooth was quickly and easily extracted without pain of any kind. What a thrill this young investigator must have felt! No wonder he was anxious to study the subject further.

Again we find the attitude of the true scientist. Here was a young man coming into his prime, with a large practice and many patients: a man who, having made a discovery, resolved at once and without hesitation to give up this large and lucrative practice to devote himself to the cause which he recognized as so great.

I must emphasize that his life was directed along a straight line toward a single purpose, the relief of suffering by the removal of bad teeth, and that the discovery of ether was only a means to the original end.

What a clear vision and a dogged persistence this extraordinary man displayed!

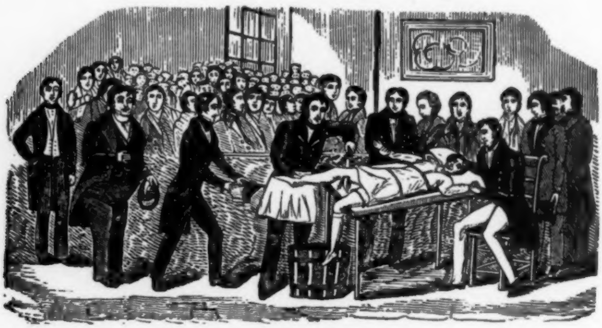
His wife writes that on October 16, 1846, the day of the great demonstration at the Massachusetts General Hospital, Dr. Morton came home to her with gloomy manner and evident depression. This gives a suggestion of what mental suffering he must have endured.

Just picture if you can this young man only 27 years old, going to an old institution there to demonstrate such a dramatic thing as ether anesthesia, to the most distinguished physicians and surgeons of that day!

Suppose the ether had not produced insensibility to pain or suppose that the patient had died from the effects.

What a tremendous responsibility he undertook and what tremendous courage and fortitude he displayed in daring to present his discovery in this way—is it any wonder that when it was over the reaction was intense?

I do not suppose that many of you realize the full significance of what Morton's discovery has meant to the world. Of course it is easy to appreciate the contrast between operations of that time and those of today. The big straps still attached to the chairs in the old operating amphitheatre at the Massachusetts General Hospital; the hooks firmly bolted to the wall; the ropes and blocks



A surgical operation prior to Dr. Morton's discovery.

in the corner—are mute evidence of what went on there at one time. I dare say all of you have smelt ether at one time or another, and no doubt many of you have been under the influence, but I doubt if any of us can have the slightest conception of what such an operation as the amptation of a leg must have been without anesthesia.

The relief of suffering has certainly been extraordinary. But aside from the purely humanitarian point of view, I am certain you can appreciate how difficult it must have been to work on a patient who was screaming and struggling during the operation. How about operations on the more delicate parts of the body, the painstaking and very careful transplanting of tendons to correct the deformity of infantile paralysis; the removal of a piece of bone from the legs to be transplanted into a spine when the

bones there are distorted by disease, or some operation on the head or brain. These things are only possible now when the patient is absolutely relaxed and quiet. The slightest slip of the surgeon's knife, or movement on the part of the patient, would spell disaster; and so the discovery of ether has extended the field of surgery to an extraordinary degree.

But the discovery of ether has led to still another series of advances.

Do you suppose that when a surgeon removed a kidney that he first removed a man's kidney? What do you suppose happens when a spleen is removed, and how could this be investigated and studied? Is it entirely safe to remove a spleen? What about the heart?

Quite recently a surgeon at the Peter Bent Brigham Hospital in Boston has been able to operate on the heart so as to enlarge the opening of one of the valves, and thus bring considerable relief to a victim of valvular heart disease.

Do you suppose that he devised the operation and then experimented first on his patient? Of course not.

The use of animals for surgery of all sorts has been quite essential—but doctors are human, just as you are; the cry of a dog or the scream of a cat is as real to them as it is to you.

The administration of ether, however, has ended the animal's suffering so that all these surgical procedures could be tried out on them without pain of any kind. On animals, operations could be performed in various ways, perhaps, to find the best method before using it on a patient. And how much animal experimentation has added to our knowledge?

I referred to diabetes and its new treatment with insulin. It was by tying off the duct of a dog's pancreas that Dr. Banting and Mr. Best succeeded in discovering this other substance which is produced by the gland.

Most of you know that diphtheria antitoxin is made from the blood of a horse which has been immunized against the diphtheria germs, and I could add other illustrations of how the use of a few animals, in an absolutely humane manner in the laboratory, has resulted in the saving of countless human lives.

And now I think of one more point. The later story of Dr. Morton's life is sad indeed. His great work was done at the age of twenty-seven, but he lived for twenty-two years afterwards a

life full of distress and anxiety. The value to mankind of his discovery was soon recognized by the hospital and by the medical societies; and we can all imagine how such an important discovery might rightly bear with it a handsome financial reward.

On this account Morton was beset by a number of men jealous of his success, who, in the hope of securing a share, large or small, in this financial return, tried to take the honor and glory from him. His former partner, who the year before had introduced "laughing gas," claimed to have given Morton the idea of producing insensibility by inhaling a gas. A man in Georgia named Long who, three years before, had administered ether to a patient, but who was so indifferent as not to realize what he had done, made a feeble effort to claim priority. A chemist in Boston and a friend of Morton, who had made some technical suggestions early in the work, tried to assume an important role.

Dr. William H. Welch has summarized the results of a controversy, which was so bitter, when he said, "The chief glory belongs to Morton's deed in demonstrating publicly and convincingly the aplicability of anesthetic inhalation for surgical purposes and under such fortunate circumstances that the knowledge became, as quickly as could be, the blessed possession of the whole world."

How different is all this from the generous, hearty co-operation which obtains today where an important discovery made in one hospital by a group of men is immediately communicated to other hospitals and other groups with the express purpose of asking those other men to try the new method, or the new drug, to see if results in different hands will be the same. And yet in spite of this hearty co-operation, the credit is placed where it belongs. This appeals to me as a hopeful thought on the development of science and of the drawing together of all workers for the common welfare.

And now, my friends, I fear I have given you something of a sermon. I am deeply appreciative of the opportunity which your Committee has given me to come before you, and I am greatly honored by being here on this occasion as the representative of such an institution as the Massachusetts General Hospital. I congratulate the town most heartily on the recognition of what Dr. Morton has done for the civilized world and on their splendid tribute to his memory.

ADDRESS OF DR. FRANK P. BARNARD

The quarryman has torn this solid block of granite from old mother earth, the craftsman has wrought it into shape, the sculptor has given us the results of his creative mind, and all have been united to form this beautiful memorial which you now behold.

The workman has set it in position, paying due respect to all natural laws, making it on the level and on the plumb, here to stand for centuries, I believe and hope.

Miss Gould, the daughter of one of the physicians present at that memorable demonstration in 1846, has very graciously and in a pleasing manner unveiled it, and to me comes the honor, and it is indeed a great honor, to be assigned the task of saying a few words concerning Dr. Morton intransferring this memorial to the town of Charlton.

I think it well to call your attention first to the origin of the movement to have this memorial erected here. A few years ago, in the office of my esteemed co-worker, Roy A. Bush of Worcester, he made the remark to me that he and Mr. Charles Sumner Dodge thought it would be appropriate to do something in the way of proclaiming to the people, that one hundred years ago there was born on yonder hill a man who became famous and whose memory should be perpetuated.

It was first taken up by the Massachusetts State Dental Society, which appropriated one hundred dollars for preliminary work. Later on it appropriated five hundred dollars and appointed a committee to work in conjunction with a committee from Charlton and neighboring towns. The committee as organized is as follows: Dr. Roy A. Bush, Worcester, President; Dr. A. A. Bemis, Spencer, Secretary, and Mr. A. F. Putnam, Charlton, Treasurer. It was our intention originally to have done this in 1919, which would have commemorated the one hundredth anniversary of Dr. Morton's birth, but conditions immediately following the signing of the armistice were such that we deemed it inadvisable to proceed, but now we have done our work and offer this to you as a finished product, the outcome of our efforts.

Thirty years ago this month I entered Harvard Dental School, commencing my professional career, and almost from the first day the names of Morton and Wells were used in much the same manner as is Edison's today in connection with any subject pertaining to electricity.

There were four men whose followers made claims for them, namely Doctors Long, Jackson, Wells and Morton, and the question was fought out for over forty years as to who actually discovered and first used ether as an anesthetic for the relief of pain in surgical operations, but, on January 29th, 1921, in the *Medical Record* appeared an article headed as follows: "William T. G. Morton, the discoverer and revealer of surgical anesthesia at last in the Hall of Fame. A Vindication. This decision is final. We cannot do otherwise, but accept it as an unbiased, unprejudiced opinion, rendered only after thorough investigation." Frances Darwin has said: "In science credit goes to the man who convinces the world, not to the man to whom the idea first occurs."

While Long waited and Wells turned back and Jackson was thinking and those to whom they talked were neither acting nor thinking, Morton, the practical man, went to work and worked resolutely. He gave ether successfully in several surgical operations, he loudly proclaimed his deeds and he compelled mankind to hear him.

Our never-to-be-forgotten Osler, with his keen sense of justice, gave us the result of his profound study of historical medicine concerning Morton's share in the discovery and promulgation of ether anesthesia in the following words: "William T. G. Morton was a new Prometheus who gave a gift to the world as rich as that of fire, the greatest single gift ever made to suffering humanity." And Professor Welch confirms the investigation of his life-long friend and says: "Surgical anesthesia has been America's greatest contribution to medicine and surgery."

The man who gave the anesthetic upon that memorable occasion, October 16th, 1846, at the Massachusetts General Hospital was Dr. William Thomas Green Morton, the most outstanding figure in American Medicine. He had experimented with sulphuric ether, had demonstrated its efficiency and sought an opportunity to show its efficiency in general surgery. He assumed the sole responsibility of the demonstration. His enterprise, his enthusiasm and his courage brought success. Whatever suggestions or assistance he may have received from others, he was the man that made anesthesia a practical, everyday blessing to mankind.

Dr. Morton was a man of pleasing personality, always faultlessly dressed, extremely courteous, and evidently controlled by a highly organized nervous system.

It was due to his restless nervous activity that anesthesia was finally brought to a public test. His advocacy and practice of anesthesia in dentistry created a host of enemies, who sought his ruin. He met them with ever renewed instances of success and finally with the famous operation of Professor Warren on the 16th of October, 1846, at the Massachusetts General Hospital. Even at this operation his enemies took advantage of a slight delay in the appearance of Dr. Morton to impress the large audience of Boston's most prominent physicians and surgeons that he did not dare face a real trial of his vaunted anesthetic. It was only at the conclusion of the operation, when Dr. Warren spoke these words: "Gentlemen, this is no humbug," that they were silenced.

William T. G. Morton studied dentistry in Baltimore, and hoped by the practice of dentistry to gain funds to study medicine. In due time he matriculated at Harvard as a medical student. He did not complete his education in Medicine, but received from Harvard the honorary degree of M. D. for his great achievements in revealing and promulgating general anesthesia in surgery. Morton died in 1869 a poor man, heartbroken because he failed to receive the recognition which was his due.

A REVELATION OF GENERAL ANESTHESIA IN SURGERY AND OBSTETRICS.

A TRIBUTE TO THOMAS GREEN MORTON.

There was a time when man believed
That pain and suffering were decreed by God.
That always at the hour of birth
The mother had to suffer and to bear
The agony which Heaven sent
Before she could embrace the child
For which her heart had longed and prayed;
And even priests who taught the word of God
Professed it was the will of the Most High.
They said, "It ever has been and it must
Forever be the same, for any change
Would be to disobey the word of God."
The mothers were resigned to suffer thus
And bear their children as it seemed decreed.
Then, with the progress of mankind in art,
In science and in industry,
With steamship, railroad, mill and factory,
Came many accidents to life and limb,
And suffering from all kinds of injury;
And with them all there still must come
The horrors of recurrent war,
With wounds from gun, from cannon and from shell.
Our fathers, skilled in medicine
And in the art of surgical relief,
Wrought wonders in their way, yet in their work

Were hindered, for the patients could not stand
The pain and suffering long enough
That needed reparation might be made.
All sorts of means were tried to still the pain
While surgeons hands sought ultimate relief,
But none seemed sure and lasting;
Until there came, inspired by Heaven,
A man who bravely faced the doubting world,
And dared to show that in God's realm
There are means of calming pain,
And during childbirth giving peaceful sleep,
And sleep to the patients while the surgeons worked
To skillfully remove or replace anew
What led again to health and happiness.
This man we honor now, as one of those
The greatest benefactors of mankind.
Disciples by the thousands in this land
And other lands, are practicing his art;
And millions of restored do call him blessed.
This man, so much revered and honored now,
Did not receive in life his due reward:
Misunderstanding and misunderstood,
He suffered much in heart and mind.
But now at last has justice come to him,
And yonder within the sacred Hall of fame,
Valhalla of our great and noble men,
We read the name of him who did reveal
Unto mankind, a gift so great, so good,
That reverently we call the gift divine,—
It came from God and was revealed through him,
Whom we to honor gather here today.
To him at last has come immortal fame:
Consilio, animis et dei gratia,—
Through wisdom, courage and the grace of God.

And now Mr. Lamb, as the official representative of the town of Charlton, I commit this into your hands for safe-keeping, knowing full well that you and your successors will cherish and care for it so long as people shall live and congregate here, or until the elements shall reduce it to dust and it returns to mother earth from whence it came.

And now let me conclude my remarks by repeating the words of Longfellow when he says:

Lives of great men all remind us
We can make our lives sublime,
And, departing, leave behind us
Footprints on the sands of time.
Footprints that perhaps another,
Sailing o'er life's solemn main,
A forlorn and shipwrecked brother,
Seeing, shall take heart again,
Let us, then, be up and doing,
With a heart for any fate;
Still achieving, still pursuing,
Learn to labor and to wait.

The Neglected Eyesight of School Children

Guy A. Henry, General Director of the Eyesight Conservation Council.

The schools of our country, taken as a whole, are neglecting a plain duty with regard to the eyesight of school children. Over and over again we hear of astonishing disclosures gathered from the reports of belated tests indicating that large numbers of children are struggling along with their school work in a vain endeavor to overcome, unaided, various degrees of defective vision, the very existence of which had heretofore been unknown. Is it fair to expect a child with one-half of standard vision and no glasses to keep up with his classmates who are free to meet their school problems without the very material draw-back of inability to see? This, without taking into consideration the added inconvenience of the often attendant headaches, nerve-exhaustion or general ill health.

The United States Public Health Service recently published a report of their findings of defective vision among a large group of children examined for physical defects in general. Dr. Taliaferro Clark, who is in charge of Field Investigations in Child Hygiene, directed and supervised the work, and the report was compiled by Selwyn D. Collins, Associate Statistician of the Service.

The examinations, carried on in certain eastern localities, included 9,245 native white children between the ages of six and sixteen in Spartanburg, South Carolina, and nearby villages; Frederick County, Maryland; New Castle County, Delaware and Nassau County, New York together with 2,535 white children in Cecil County, Maryland.

The results of the tests were merely for visual acuity made with standard test type, so that only the manifest deficiencies were recorded. Even with these simple tests, however, but 63 per cent were found to be normal in both eyes. Moderate defects were present in 27 per cent of the children, while as high as 10 per cent had vision as low as 5/10 of standard vision or less in one or both eyes.

That school life is in all probability a contributing cause to poor vision is brought out by the fact that the number of children with marked defects of vision at sixteen years of age was four times as great as the number at six years of age.

It is interesting to note that approximately the same proportion of boys as girls were found to be defective, though more of the girls had moderate defects. Generally speaking, also, there were as many defective right eyes as left, though, here again, it was found that at times one eye would be perfect along with one seriously imperfect.

This brings us to the most striking portion of the whole report, that which tells the story of neglect. Even among the older children, those between fourteen and sixteen years of age, but 23 per cent of those needing glasses were wearing them. Of the children having 5/10 vision—one-half of standard vision—or less, and there were 925 in this group, only 10.9 per cent had been fitted with any kind of correction. Even more deplorable is the fact that only 22 per cent of those with vision as low as 3/10 or less in *both* eyes were wearing glasses, and of those with 3/10 vision or less in one eye accompanied by normal vision in the other, as few as 10 per cent were wearing glasses to help along the poor eye.

It rests with the schools to endeavor to eliminate this state of affairs. Regular periodic eye examinations at least once each year would detect the manifest defects. The efforts of school authorities should then be directed toward impressing the parents with the seriousness of neglected visual defects, so that all children requiring glasses would be fitted with corrective lenses.

It must also be remembered that glasses alone will not bring about the desired results. As many contributing *causes* to eyestrain as possible should be weeded out, thereby permitting the minimum amount of faulty vision to exist. Care should be taken to provide the best possible school-room lighting, both natural and artificial. Light from the windows should be controlled by shades, and the finish on the desk tops dull to avoid unnecessary glare. Blackboards should be placed so that they receive a good light—never between nor under windows. Among the primary precautions is the use of proper book type. All school books should have large, clear type on dull paper.

If these measures are takes to eliminate eyestrain, together with regular periodic eye examinations, a big step will have been taken toward the conservation of the eyesight of our future citizens.

Educational Campaign Instituted by Proctor & Gamble

The importance of keeping school children in touch with the practical side of life and responsive to the interest inherent in everyday things is recognized by the Procter & Gamble Company, who have recently prepared an "Educational Exhibit" under the supervision of Dr. F. G. Bonser of Teachers College, Columbia University, New York City.

This Educational Exhibit consists of charts showing the history of soap and the process of soap manufacture. The charts also illustrate pictorially the history of the bath as shown by development of the use of soap throughout the centuries. It is planned that each exhibit will be accompanied by appropriate descriptive matter and concrete specimens.

A booklet, "Suggestions to Teachers," which accompanies each chart exhibit, makes valuable suggestions regarding the use of the exhibit in connection with regular school work, in health lessons; for household arts; for history study; in connection with geography; for nature study and science; for industrial arts; for parents' meetings; for assembles, school exhibits, etc.

An interesting development both on the art and educational side is the recent discovery by sculptors of the adaptability of white soap as a medium for sculpture. A recent competition and exhibition conducted by the Art Center in New York City for prizes offered by the Procter & Gamble Company resulted in the exhibition of six hundred entries from all parts of the country and created a widespread interest in this medium for sculpture. The use of white soap for sculpture training is particularly valuable in schools, since it affords an inexpensive medium for developing latent talent.

Summer Courses in Science

Boston University, Boston, Mass.

Biology. Lectures and laboratory on general principles of biology. Synoptic survey of plant and animal kingdom. Evolution and heredity. *Prof. Arthur Weysse*

Chemistry. Lectures and laboratory. Special work for high school teachers. *Prof. Lyman C. Newell*

General Physics. Lectures and laboratory. *Prof. Norton A. Kent*

General Science—Physics. Lectures in physics for general science teachers. *Prof. Norton A. Kent*

Advanced courses in the above subjects and courses in astronomy and geology are also given.

Columbia University, New York City.

Principles and organization of science in secondary schools. Relation of different science courses. Considerable attention paid to general science. Methods of determining results of science teaching. *Mr. E. R. Glenn*

The teaching of general science in secondary schools. Content, methods, texts, demonstrations and laboratory work. *Prof. S. R. Powers*

The teaching of biological sciences in secondary schools. Problems of high school biology teachers. Field trips. *Mr. C. W. Findley*

The teaching of physics in secondary schools. Subject matter, texts, manuals, demonstrations, tests and reference readings of the high school physics course. *Mr. E. R. Glenn*

The teaching of chemistry in secondary schools. Modern theories and practices of teaching chemistry in secondary schools. *Mr. A. I. Lockhart*

Regional Studies in Science. A science of type field regions in and about New York City. *Mr. C. R. Findley*

The teaching of science in the elementary school. Selection and organization of subject matter. Relation of nature study and other types of school work. *Mr. H. R. Sperry*

Special problems in science teaching in secondary schools. Discussion of special studies already made. Special investigation by students. Open only to advanced students. *Prof. S. R. Powers*

Cornell University, Ithaca, New York.

Chemistry. Eighteen courses of all degrees of advancement and teachers' courses.

Physics. Eighteen courses from beginners to advanced research and teachers' courses.

Biology. Twenty courses making complete offering for teacher and research worker.

Earth science, astronomy, meteorology and climatology are in the list also. Courses given chiefly by members of the regular Cornell staff.

Hampton Institute, Hampton, Virginia.

The teaching of general science. *W. G. Whitman*

The teaching of high school physics. *W. G. Whitman*

INDIANA UNIVERSITY, Bloomington, Indiana.

Chemistry. General inorganic chemistry. *Mr. Mathers*
Inorganic chemistry for home economic students. *Mr. Lyons*
General physics. *Mr. Dutcher*
Radio. *Mr. Ramsey.*
Life views of great men of science. *Mr. Nicholson*

Many advanced courses in chemistry and physics, and courses in botany, zoology, geology and physiology are offered.

MASSACHUSETTS INSTITUTE OF TECHNOLOGY, Cambridge, Mass.

Methods of Teaching General Science in Junior High Schools. *Joseph R. Lunt*
Methods of Teaching Science in Senior High Schools.
Physics, *F. R. Miller*
Chemistry, *C. H. Stone*

NEW YORK UNIVERSITY, Washington Square, New York City.

General Science. Teaching general science in the upper grades of the elementary school and in the junior high school. *Dr. Bedford*

General Chemistry. Lectures and laboratory work in general chemistry. *Dr. Miller*

General Physics. Lectures and laboratory work. *Dr. Petersen*

Photography. Lectures and laboratory course. *Mr. Root*

Advanced chemistry and physics and courses in geology, biology, physiology and hygiene are also offered.

OHIO STATE UNIVERSITY, Columbus, Ohio.

Methods of High School Science Teaching. Educational value of science; scientific method; testing; special problems in each science. *Prof. George R. Twiss*

Methods and Problems of the Physical Sciences. Illustrated lectures; conferences; reports. *Prof. George R. Twiss*

UNIVERSITY OF CALIFORNIA, Los Angeles, California.

Outlines of General Science. Lectures, demonstrations and conferences. *Prof. W. C. Morgan*
General Biology. *Prof. B. M. Allen*
Chemistry Course for Teachers. *Prof. W. C. Morgan*

UNIVERSITY OF PENNSYLVANIA.

Principles of Teaching General Science. *Dr. Wildman*
Content Course in General Science. *Dr. Wildman*

UNIVERSITY OF WISCONSIN, Madison, Wisconsin.

The Teaching of Botany. *Prof. G. M. Smith*
The Teaching of Chemistry. *Prof. J. H. Walton*
The Teaching of High School Physics. *Prof. B. W. Snow*
The Teaching of General Science. *Prof. I. C. Davis*
The Content of General Science. *Prof. I. C. Davis*
Agricultural Bacteriology. *Prof. W. H. Wright*
Medical Bacteriology. *Prof. P. F. Clark*

Besides these there are science courses for students of all stages of advancement.

The New Books

Human Body and Health; Revised—Alvin Davison—American Book Company. Elementary—191 pages—98 illustrations. Intermediate—223 pages—150 illustrations. Advanced—320 pages—200 illustrations.

The elementary and intermediate books are for younger grade children, and treat important health topics in a simple but effective way. The advanced book is suitable for older grammar grades, junior high, or even lower senior high grades. It contains enough anatomy and physiology to give significance to the hygienic treatment. The whole series is well graded, and provides a complete treatment of this most important of all school studies,—health.

Health Lesson; Revised—Alvin Davison—American Book Co. Book I—191 pages—98 illustrations. Book II—288 pages—188 illustrations.

These books treat the essential topics of health which are vital to human welfare. They are attractive in appearance, and written down to the younger pupils in the fourth to sixth grades. The revision brings these books up to date in their subject matter. Book I is the same as Human Body and Health—Elementary (reviewed above), and Book II includes all of Human Body and Health—Intermediate, and six chapters additional.

Elements of General Science Laboratory Problems—Caldwell, Eikenberry and Glenn—197 pages—74 figures—72 cents—Ginn and Company.

This new edition is a handy, pocket-style, in contrast to the former large-page laboratory manual by these authors. The book has 83 experients or problems, which are excellent for General Science. A statement of the problem is given at the beginning of each exercise. Questions on the experiments aid the pupil in a complete understanding. Reading references and optional problems accompany each exercise.

The Early Embryology of the Chick—Bradley M. Patten—176 pages—63 illustrations—P. Blakiston's Son and Company.

The purpose of this book is to provide a brief and simple text for the beginning student in vertebrate embryology. The development covered is for the first four days of incubation. The large number of illustrations with the descriptive text, make this an admirable book on the subject.

Applied Electricity—R. B. Delano—205 pages—Illustrated—D. C. Heath & Co.

This little book contains 65 experiments covering as many practical electrical problems. It makes the basis of a valuable course in applied electricity. Collateral reading will, of course, be necessary. It also offers much help to those who wish to assign projects in electrical subjects for individual investigation. Part I deals with magnetism, types of cells, electro-chemical problems, electro-magnetic devices, resistance, motors, dynamos, connections, meters, lamps and the furnace. Part II covers wiring experiments, including house wiring plans. Part III treats of alternating currents, induction, transformers, rectifiers and rotating magnetic fields. The book is attractive and should find a useful place in our schools.

General Science Scale—August Dvorack—Public School Publishing Co., Bloomington, Ill.

These tests are to measure the child's achievement or progress in general science. The material has been selected from an analysis of 18 texts. There are three forms. Form I is for testing early in the year to classify pupils according to their needs. The other two measure progress or achievement at the end of the year. Each form is made up of three groups, and the average value of each group is given. Each group comprises twenty statements. In each statement there are five alternate words or phrases from which the pupil is to select the one which makes the statement most true. This appears to be a test that is well worth while.

The Technical Vocabularies of the Public Schools Subjects—Section 6—General Science—Luella C. Pressey—16 pages (paper)—$1.50 per package of 35—Public School Publishing Company.

This is a list of important technical words appearing in general science tests. It is intended that the lists be placed in pupils' hands and that they should look up those that belong to topics which they have covered, provided they do not understand them. It is claimed that the mastery of the technical terms of a subject will bring mastery of the important ideas of the subject.

Solid Geometry—John W. Young and Albert J. Schwartz—399 pages —328 figures—Henry Holt and Company

This is a small but attractive volume. It has reduced the theorems to a minimum, but added many applied problems. It encourages the pupil to independent thought and is in line with modern educational ideals.

Eyesight Conservation—Bulletin 5—95 pages—Ill.—40 cents—Eyesight Conservation Council of America—Times Building, N. Y. C.

This bulletin contains illustrations of lantern slides on eyesight conservation which may be procured for school use from the Eyesight Conservation Council at small expense. They may be purchased or rented. The bulletin also contains the descriptive matter to go with the slides for use in presenting a lecture. Many useful facts of value to teachers will be gained from the bulletin, even though the slides are not used.

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Can we prevent an aerial holocaust. A. Klemin. Sci. Amer. 132:94. Feb. 1925.

When men race with death to make the air safe. Ill. Peter Vischner. Pop. Sci. Mo. 106:1:36. Jan. 1925.

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The alchemist. Ill. Paul D. Foote. Scientific Mo. 19:239. Sept. 1924.

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The sun's place in the universe. Sci. Am. 132:140. Feb. 1925.
Interviewing the stars. Ill. William J. Showalter. Nat'l Geog. 47:96-122. Jan. 1925.
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The show of your lifetime. Ill. H. M. Hall. Pop. Science Mo. 106:1:44. Jan. 1925.
Meteoric shower. Ill. D. H. Menzel. Sci. and Inv. 12:763. Dec. 1924.
Solar eclipse of Jan. 24, 1925. Ill. Isabel M. Lewis. Sci. and Inv. 12:889. Jan. 1925.
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The astronomy of Shakespeare. John C. Dean. Scientific Mo. 19:400. Oct. 1924.

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Solar systems inside the atom. Ill. Sci. Amer., 132:80. Feb. 1925.
The world of whirling electrons. Ill. W. Grunstun. The Experimenter, 4:164. Jan. 1925.
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A hundred years of electrical engineering. G. W. O. Howe. Scientific Mo., 9:290. Sept. 1924.

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Discovering life expectancy of standard fools. J. K. Russell Nations Health, 7:96. Feb. 1925.
Food fairies' party (A play). Edna Schaeffer. Am. Food Jour., 20:23. Jan. 1925.

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Twenty-eight autochromes lumière. Nat'l Geog. Mag., 46:529-544. Nov. 1924.

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Common sense with the garden plan. J. H. Sperry. Gar. Mag. 40:302. Jan. 1925.

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Stimulation of plan growth by electric lights. Ill. V. A. Tiedjens. Trans. Ill. Eng. Soc., 19:1011. Dec. 1924.

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Porto Rico, the gate of riches. Ill. 12 pages in colors. John O. La Gorce. Nat'l Geog. Mag., 46:599-651. Dec. 1924.

POWER

Endless power twelve miles under our feet. Ill. Raymond J. Brown. Pop. Sci. Mo., 105:6:54. Dec. 1924.

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RADIO

Installing a radio set. A. P. Peck. Radio News, 6:1156. Jan. 1925.

The radio—photo letter. Ill. S. R. Winters. Radio News, 6:1386. Feb. 1925.

RECREATION

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SANITATION

What is a sanitary drinking fountain? Am. City, 32:183. Feb. 1925.

Garbage and trash collection. C. H. R. Fuller. Am. City, 32:54. Jan. 1925.

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Cairo to Capetown overland. Ill. Felix Shay. Nat'l Geog. Mag., 47:123-260. Feb. 1925.

VIVISECTION

The truth about antivivisectionists. E. H. Baynes. Hygeia, 3:65. Feb. 1925.

WATER SUPPLY

The cities water supply (for class study). Am. City, 32:131. Feb. 1925.

Leading a river across the desert. Los Angeles supply. E. C. Crossman. Scie. Am., 132:92. Feb. 1925.

New water supply for Tulsa, Okla. Ill. W. R. Holway. Am. City, 31:553. Dec. 1924.

VACUUM TUBES

The vacuum—there is something in it. Ill. The Experimenter, 4:— and 224. Dec. 1924 and Feb. 1925.

Magazine List

American City. 443 Fourth Ave., N. Y. C. Monthly. $4.00 a year, 50c a copy. The science problems of city and rural communities are treated in numerous articles, well illustrated. A valuable student and teacher reference.

The American Food Journal. 25 E. 26th St., New York City. Monthly. $3.00 a year, 25c a copy. Articles on food manufacture, food legislation, and experiments in nutrition.

Commercial America. Phila. Com'l Museum, Phila., Pa. $2.00 a year. Ill. Commercial production. New inventions. Will interest commercial geography and science teachers.

The Educational Screen. 5 South Wabash, Chicago, Ill. Monthly except July and August. 20c a copy, $1.50 a year. Now the only magazine in the field of visual education, having absorbed *Moving Picture Age* and *Visual Education* during the past two years. It covers the entire field of visual aids, including the motion picture, authoritatively. It is independent of any commercial connection whatever.

Garden Magazine. Garden City, N. Y. Monthly. 25c a copy, $3.00 a year. Ill. Helpful to amateur gardeners, teachers and pupils.

General Science Quarterly. Salem, Mass. Quarterly. 40c a copy, $1.50 a year. The only journal published devoted alone to science in the elementary and secondary schools. It tells what schools are doing in science, gives lesson plans, demonstrations, and an extensive bibliography of usable articles in current periodicals.

The Geographical Review. Broadway at 156th St., N. Y. Quarterly. $1.25 a copy, $5.00 a year. Devoted to scientific geography. Original maps and pictures. One department contains condensed items of topics of current interest.

The Guide to Nature. Sound Beach, Conn. Monthly. 15c a copy, $1.50 a year. Ill. Of interest to elementary pupils and teachers of nature study.

Hygeia. 535 No. Dearborn St., Chicago. Monthly. 25c a copy, $3.00 a year. Popular articles on individual and community health. A valuable supplement to classroom work in hygiene.

Industrial and Engineering Chemistry. Box 505, Washington, D. C. Monthly. 75c a copy, $7.50 a year. A technical journal which contains much material which teachers can use.

Journal of Chemical Education. Easton, Pa. Monthly. $2.00 a year. Promotes chemical education; primarily a journal for the chemistry teacher. Digests of activities of chemical associations.

Journal of the Franklin Institute. Philadelphia, Pa. Monthly. 50c a copy, $6.00 a year. Ill. A technical journal. Contains many articles of value to science teachers.

Journal of Home Economics. 1121 Cathedral St., Baltimore. Monthly. 25c a copy, $2.50 a year. For teachers.

The Literary Digest. 354 Fourth Ave., N. Y. Weekly. 10c a copy, $4.00 a year. Has a department "Science and Invention." Articles are mostly digests from other journals. They are popular in nature and suitable for high school pupils.

National Geographic Magazine. Washington, D. C. Monthly. 50c a copy, $3.50 a year. Best monthly journal for high grade pictures. Articles are of interest to general reader, pupils and teachers, as well as to geographers.

The Nation's Health. 22 E. Ontario St., Chicago, Ill. Monthly. $3.00 a year, 25c a copy. An illustrated magazine devoted to community, industrial and institutional health problems. Very helpful to the science and hygiene teacher.

Popular Mechanics Magazine. Chicago. Monthly. 25c a copy, $3.00 a year. Short science items and articles well illustrated. Appeals strongly to elementary pupils. Suggests many construction projects.

Popular Science Monthly. 255 W. 39th St., N. Y. C. Monthly. $2.50 a year, 25c a copy. A review in text and pictures of the news of science and invention, presented in a humanistic and inspirational way. Used as a supplement to text-books in many high schools. Valuable to science pupils and teachers.

The Science Classroom. Issued by "Popular Science Monthly," October to June. 25c a year. A valuable teacher's aid, giving lesson plans, experiments, and many reference suggestions for secondary science teachers.

The Experimenter. 53 Park Pl. New York City. Monthly. 25c a copy, $2.50 a year. This is especially suggestive to boys who are making things. There are numerous articles on electrical, radio and chemical topics.

Radio News. 53 Park Place, New York City. 25c a copy, $2.50 per year. Monthly. A practical periodical for all who are interested in radio. Gives radio progress, new hook-ups, and gives much help to one who may wish to construct his own set.

Safety Engineering. 80 Maiden Lane, New York. Monthly. $3.00 a year. 25c a copy. A journal devoted to conservation of life and property and contains much material helpful in science classes.

School Science and Mathematics. Chicago. Monthly. $2.50 a year. A teacher's journal. Includes many helpful suggestions.

Scientific American. Woolworth Building, N. Y. Monthly. 35c a copy, $4.00 a year. Has longer articles than the other popular science journals. Illustrated, and is particularly valuable to high school science pupils and teachers.

Science and Invention. 53 Park Place, N. Y. C. Monthly. 25c per copy, $2.50 a year. Ill. Popular articles on astronomy, physics, photography, radio-activity, medicine, and, in fact, science in general.

Scientific Monthly. Garrison, N. Y. 50c a copy, $5.00 a year. Articles as a rule are more along lines of pure science. Much of value to teachers. Articles can be read to advantage by many pupils.

Science News-Letter. Science Service, 1115 Connecticut Ave., Washington, D. C. Weekly. 10c a copy, $5.00 a year. Gives a valuable current summary of the progress of science, in a form usable in science classes.

Transactions of the Illuminating Engineering Society. 29 West 39th St., N. Y. Monthly. $1.00 a copy, $7.50 a year. Technical. Many articles contain material which can be used in high school classes.